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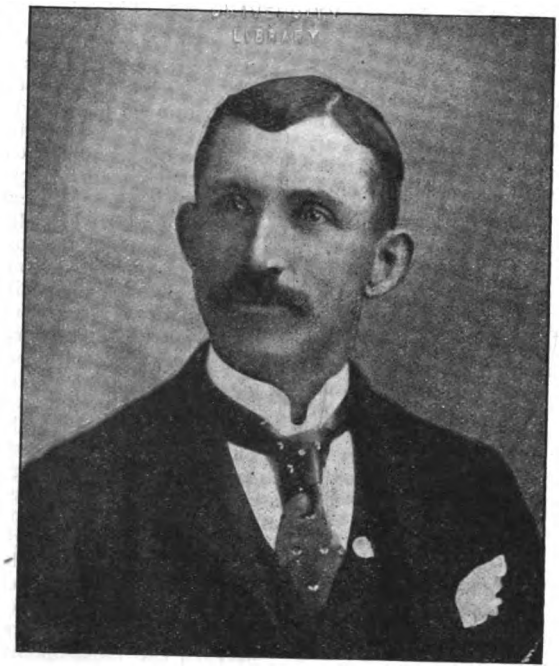
The Electrical Age.

VOL. XXI—No. 1 NEW YORK, JANUARY 1, 1898 WHOLE No. 555



Capt. John McLeod Murphy, Inventor of the Safety Third-Rail Electric System.

THE SAFETY THIRD-RAIL SYSTEM.

The inventor of the above system, Capt. John McLeod Murphy, comes of old American stock. His grandfather, during the years 1802 and 1803, was mayor of New York City. The fighting blood of the family showed itself in his father, Capt. William Jay Murphy, a captain in the Civil War and pilot of the famous steamship Great Eastern. His uncle, John McLeod Murphy, was an officer in the United States Navy, and the author of the above invention was born and bred in New York City. His varied and interesting career may be outlined briefly by saying that he served as an apprentice boy on the frigate Minnesota; in 1875, nearly three years on the sloop of war Supply, during which time he saw the Madeira Islands, the West Indies, and the southeast coast of Africa. In 1880 he joined the New York Fire Department, being the first member and practically the originator of the present Life Saving Corps. In 1881 the first call for volunteers was made for the purpose of organizing a Life Saving Brigade. For several weeks the only name on the list was that of Capt. John McLeod Murphy. During the famous fire on Leonard street in 1887, when the building collapsed on four men, he was the only survivor. In 1889 he left the fire department and went into mining in Nevada. He served as engineer at the Butte City mines, returning in 1891 to his birthplace.

From this period his time was devoted to the study and development of electric roads. He is the creator of the third-rail system, and a road built under his direction operates successfully at Westport, Conn. On the basis of his further work he has organized a corporation called the Safety Third-Rail Electric Company, with William M. Keepers, president; David F. Halstead, treasurer, and Capt. J. McLeod Murphy, secretary. This is a New Jersey corporation with a capitalization of $500,000.00, and paid in capital of $10,000.00. The office of the present company is in Temple Court Building, New York. The model displayed for inspection there combines all the essential features required for the successful operation of a safety third-rail electric system.

The general operation is as follows: The motorman turns a switch and thereby allows current, coming from storage batteries within the car, to enter an automatic electro-magnetic switch, a succession of which are arranged within a vault at intervals along the road, each vault containing switches sufficient to control one block of the system, that is, about two hundred feet. When the current circulates from the storage cells into this switch, the main feeding circuit is closed at once and the local circuit causing this operation is instantly and automatically opened. As the car moves along each device performs its function in like manner, the switch being primarily controlled by a few cells of storage battery within the car. The sections of middle rail are less than the length of the car, and contact is made with them by a device attached to the bottom of the car. The car always rests above two rail sections, and therefore can always move the instant the switch operates. At an exhibition given in Washington, D. C., at Odd Fellows' Hall, Seventh and E streets, lasting two days during the fall of last year, some very notable people were present—United States Commissioner Black with two associates. In addition, his electrical staff, of which Inspector Allen is chief; Mr. M. D. Helm, of Washington, D. C., representing several surface roads, with his consulting engineers; Chief Electrician Beardsley, of the Government Printing Office; a representative of Munn & Company; Deputy Commissioner of Patents; several examiners and several electrical experts from Philadelphia, Wilmington, Pittsburgh and Richmond, as well as members of the press.

In order to obtain the opinions of experts regarding the safety third-rail electric system, the following gentle-

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men were called upon to examine and criticise the invention of Capt. Murphy :

OPINIONS OF EXPERTS.

MR. R. H. BEACH, OF THE GENERAL ELECTRIC CO.

I have examined the Safety Third-Rail Electric Company's System, and have witnessed an exhibit of the same, and cheerfully endorse the system. I believe that all of the objections which have been found in other surface contact systems have been met and overcome, and I believe that this system will revolutionize the methods of operating long and short distance roads as well as street railroads. The switch used in this system is the only non-arcing to my knowledge that will fill the bill.

MR. AMSTERDAM'S OPINION.

I have watched the progress for a number of years in the matter of improvements in electrical propulsion, and have always denounced the possibility of operating successfully a *surface contact system* with any degree of *safety* and *economy*, but I am forced to admit that it is a perfected success in the invention of the Safety Third-Rail Electric Company's System. I witnessed an exhibit of their *system* and cheerfully endorse it. In their switch they have an invention perfected, which, as an expert of many years, I am surprised that it is possible to get the result in such a simple and inexpensive manner, and dispense with *arcing* beyond a question of a doubt.

MR. VANDERVEER, OF THE BROOKLYN HEIGHTS RAILROAD COMPANY

I personally tested the switch of the Safety Third-Rail Electric Company, at the Power Station at 52d Street and 2d Avenue, Brooklyn, N. Y., on the main line circuit, with a voltage of 560 volts and 200 amperes, and the switch operated beyond all expectations, and was a complete success. It made and broke contact without the slightest indications of arcing and in dead short circuit. I am satisfied the switch is a grand success and cannot fail unless some one is guilty of some dirty trick.

MR. E. V. BAILLARD'S OPINION.

I made the switch for the Safety Third-Rail Electric Company, and was present and assisted in the test at the Power Station of the Brooklyn Heights Railroad Co., at 52d Street and 2d Avenue, and testify to the truth of the statement of Mr. Vanderveer.

P. M. MOWREY & COMPANY'S REPORT OF THE SAFETY THIRD-RAIL COMPANY'S SYSTEM MADE TO MR. WM. M. KEEPERS UNDER DATE OF SEPTEMBER 7TH, 1897.

After a very careful examination of your Safety Third-Rail Electric System, and carefully looking into all other systems, and making examinations of patented systems of record to date, we beg to state that our judgment is, that in the Safety Third-Rail System you have an invention that will *revolutionize the present methods of electrical propulsion for long and short distance as well as surface street railroad systems.* In your switch we claim it is impossible to create an *arc.* In our report we have carefully prepared estimates taken from actual operations, and are thoroughly correct and reliable in every respect for strictly high grade first-class construction work, but they can be reduced by at least 25 to 33⅓ per cent. for inferior grade of work such as is used in inter-urban work, which report shows your system stands really without competition. A very important feature of your system is, you do away with deep excavation.

In reviewing the features of the safety third-rail system it appears to the engineer as a surface system that carries all the features of both overhead or conduit, and is adaptable to either horse, cable, underground, elevated or steam roads.

It is a third-rail surface system in which the current (electricity) is only applied to the third rail by the motorman upon the front platform of the moving car, where he has absolute control through the medium of the controller of the power from the power-station, thereby rendering all rails non-electric, rails upon which the car stands inclusive, and removing any and all danger from a shock.

If a main feed-wire should, from any cause, become broken, or the power-house become temporarily disabled, provisions are, in this system, provided whereby the car can be continued (en route) to the end of its destination (limited). At the same time the lights, as well as the heat, are very ingeniously cared for. The losses atributable to other systems are greatly reduced; gas and water pipes, to say nothing of electric-bell equipment along the route are not affected by electrolysis. This system saves 30 per cent of the losses practically attributable to any other systems. The system of feeding is absolutely insulated, not alone on the positive feed circuits, but also on the return or negative circuit. The contact maker or breaker is a non-arcing switch, and can only be effected by the motorman, and *not the car.* Cost of construction is not in excess of the overhead, and much cheaper than the underground or conduit systems, and its cost of maintenance is much less than half of any other system. In practical operation this system not only provides light for the car but also light along the entire route, which lights are effected by the passing car, and can be lit as signals at grade crossings, etc., and dispenses with continuously lighted circuits. The lighting and extinguishing of the lights does not require the attention of the motorman, but is automatically operated by the car. One, two, three, or a large number of cars can be operated, dash-board to dash-board, as often occurs in blocks, break-downs, etc., and each car independently manipulates the switches without interfering with the car ahead or behind.

The switches can be buried even with the surface, or can be clustered any number together, placed in the most convenient locality. It is not necessary to excavate to a depth greater than that of the ties, thus largely decreasing cost over any other system. Horse, cable, overhead, conduit, steam or elevated can be equipped with this system without interfering with a single trip. This system does not require specially constructed motors, controllers, etc., but is operated with the electrical epuipments now generally in use; and overhead or conduit electrical cars can, at a very small cost, be changed to operate under this system.

Short circuiting impossible.

In suburban steam roads the equipment of this system forms no obstruction to general traffic by steam cars, should it be deemed necessary to run over the rails of this system.

ANALYSIS OF ESTIMATE FOR INSTALLING FIVE MILES OF THE MURPHY THIRD-RAIL SYSTEM (DOUBLE TRACK).

1515 tons of 90 pound Girder Rails	$32,300.00
270 tons of 30 pound "T" Rails	5,400.00
13,500 Split Oak Ties	6,750.00
2,850 Switches (570 per mile double track)	11,400.00
95 Vaults (at $100 per vault)	9,500.00
27,000 feet of Conduit for track and feeders	4,050.00
54,000 feet No. 4/0 Lead Covered Wire (Feeders)	15,120.00
35,000 feet No. 2/0 Lead Covered Wire (Switch Feeders)	7,700.00
23,500 Cubic Yards Broken Stone	2,350.00
35,000 " " Excavation	17,500.00
13,000 Cubic Feet Asphaltum for Roadbed	8,125.00
Incidentals 10 per cent	12,019.50
Labor	8,000.00
Profit	14,021.50
Total	$154,236.00

or at the rate of $30,847.20 per mile of double track.

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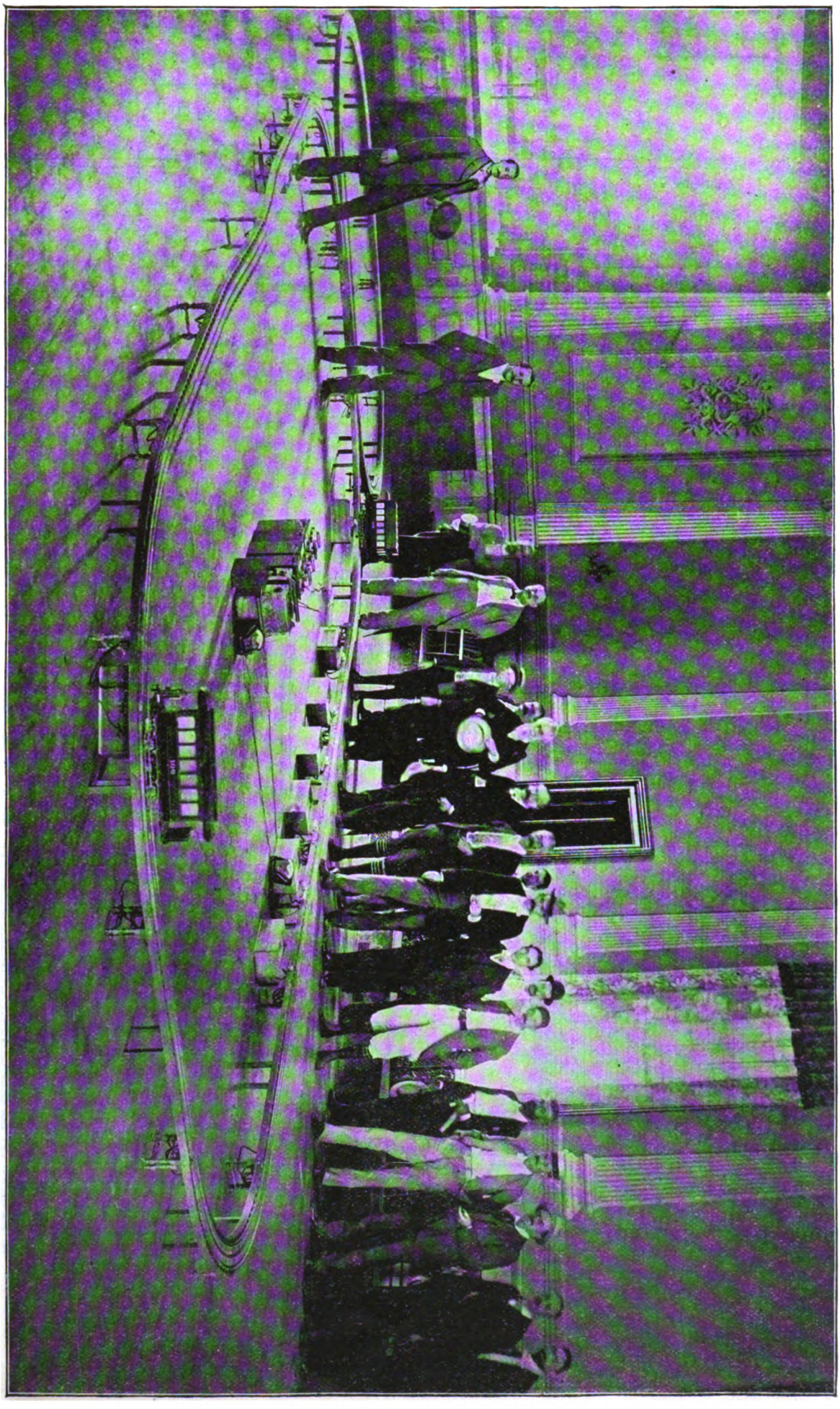

Exhibition of the Safety Third-Rail System at Odd Fellows' Hall, Washington, D. C.

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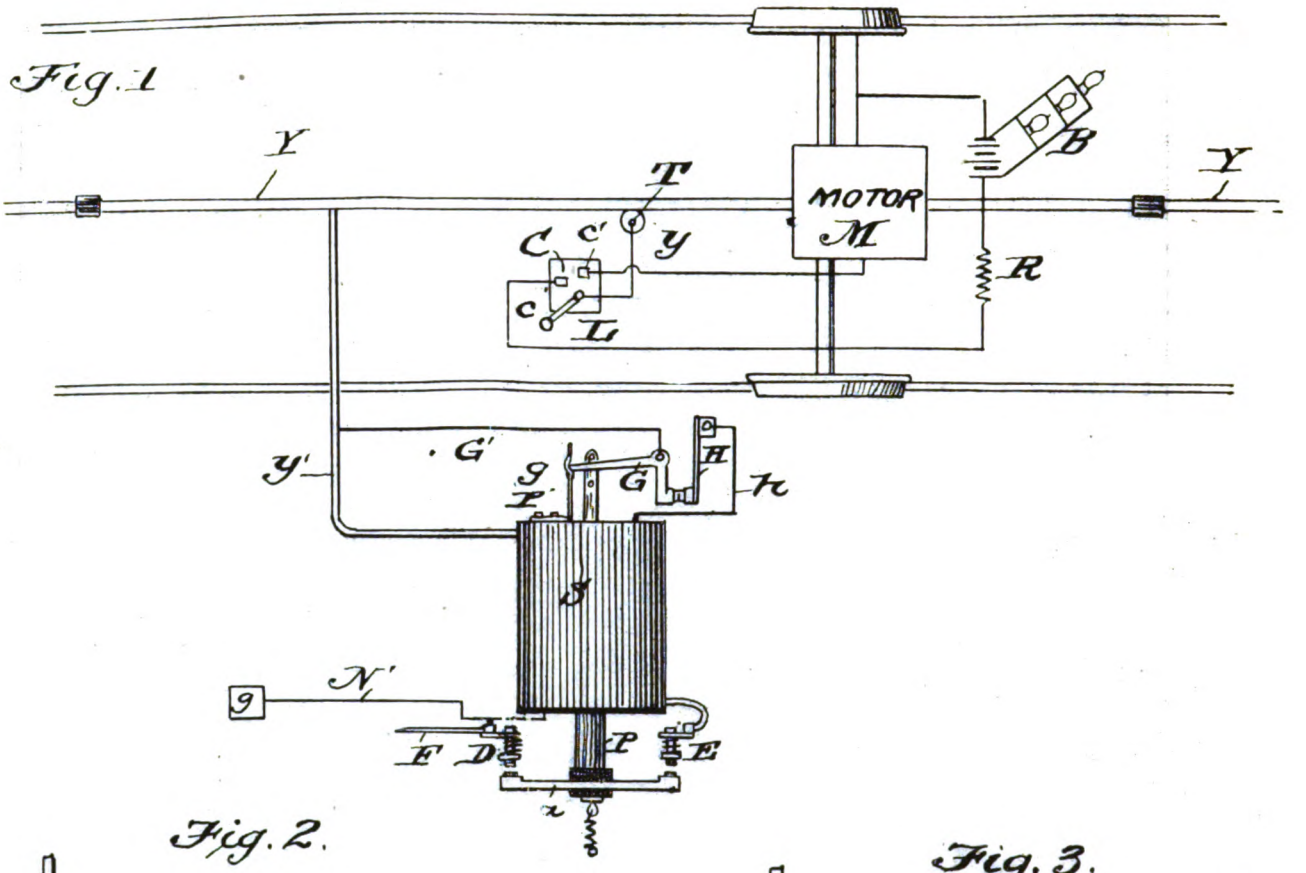

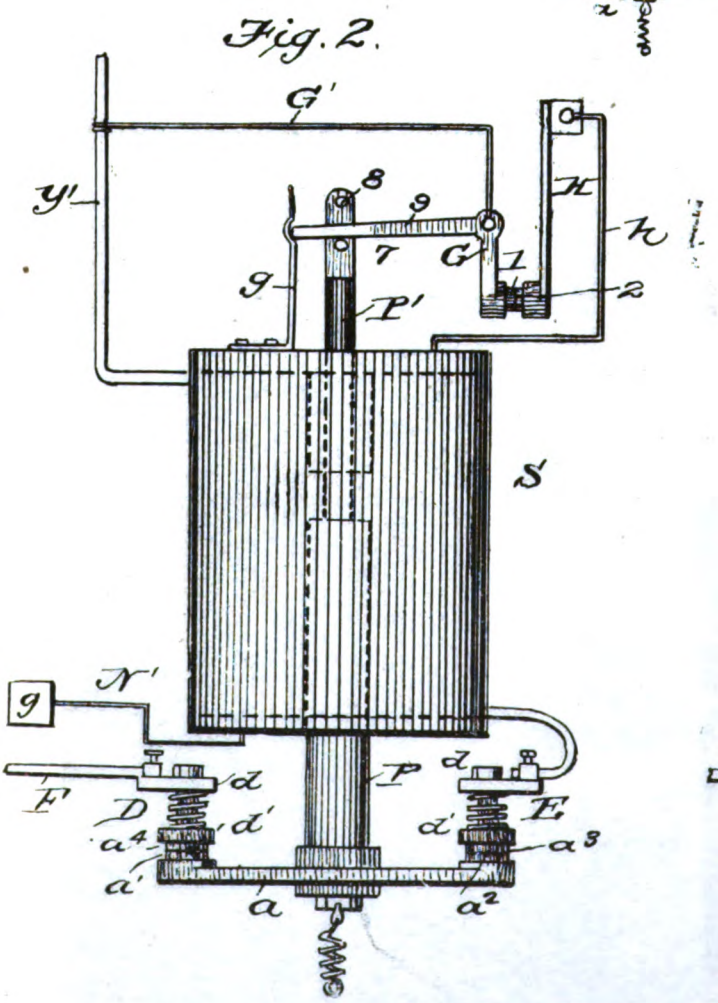

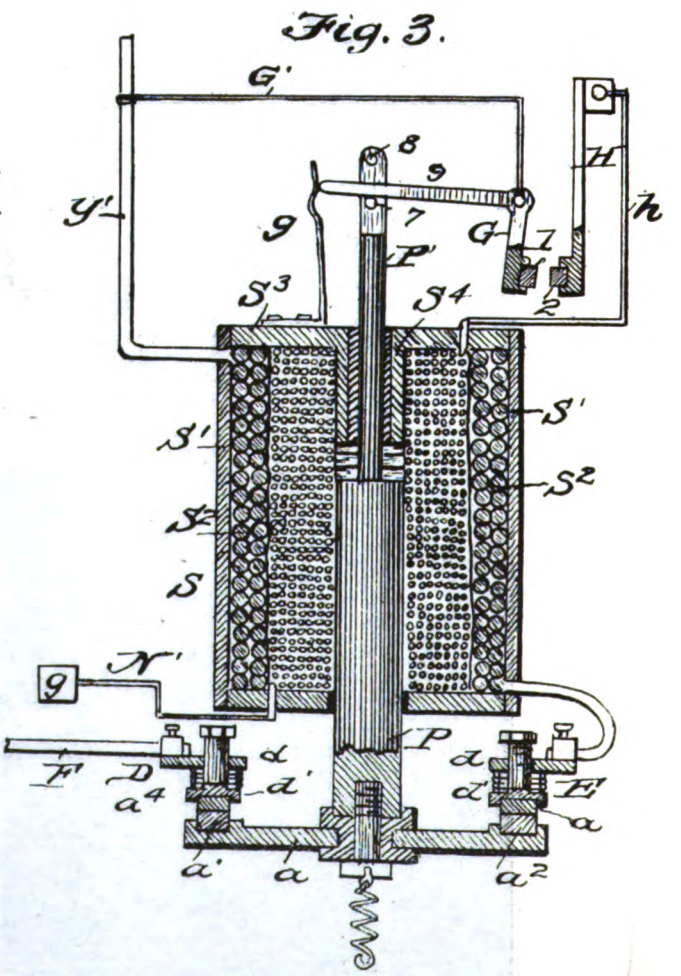

Fig. 1—Connections between Rail, Motor and Switch.
" 2—External Appearances and Connections of Switch.
" 3—Sectional View of Automatic Non-Arcing Switch.

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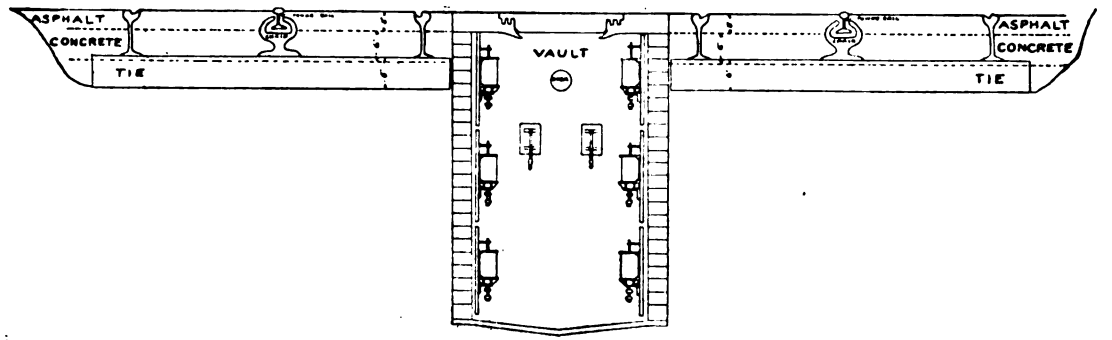
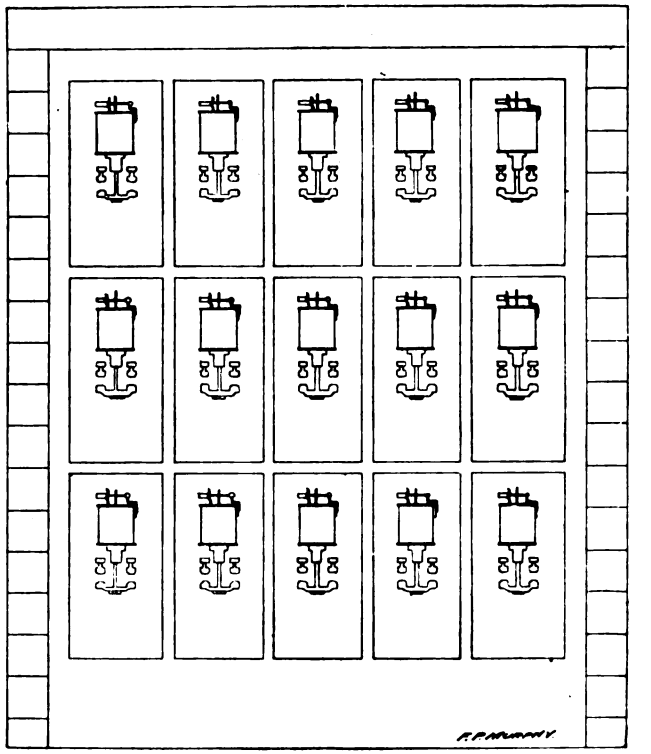
SAFETY THIRD RAIL ELECTRIC CO.

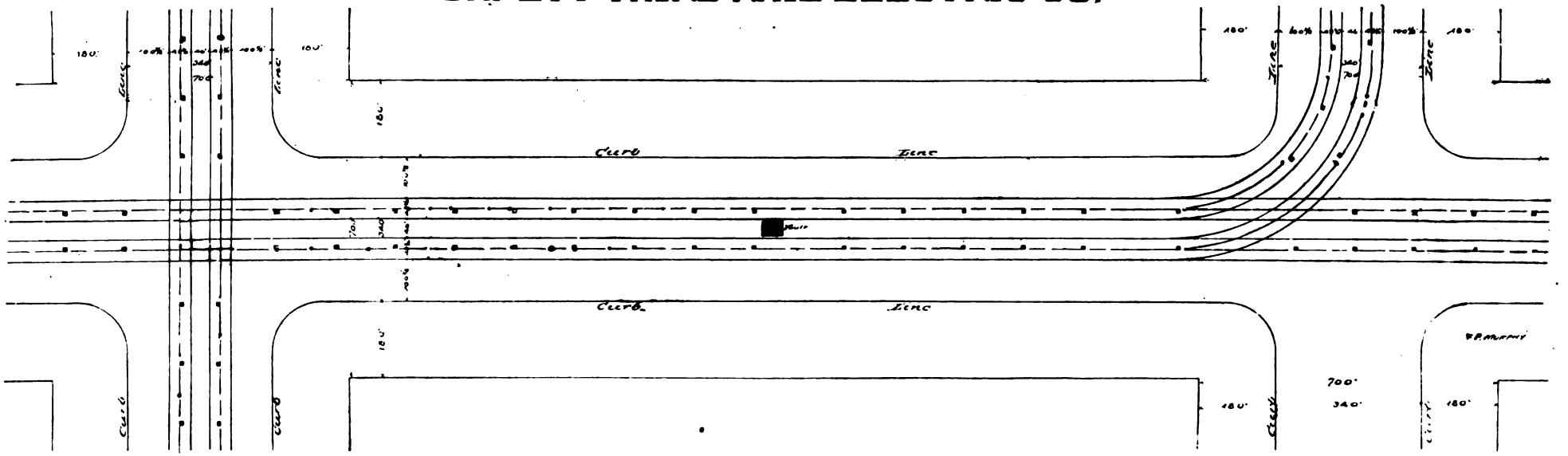
ROAD BED & VAULT



SIDE VIEW OF VAULT



SAFETY THIRD RAIL ELECTRIC CO.



Details of Track Construction, showing Vault, position of Switches and Method of turning Curves.

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THE ENCLOSED ARC LAMP.

(Continued from page 330.)

(Section of article left out of last issue.)

The best regulation was obtained from lamps Nos. 3 and 7. Although the arc has more chance to move about on the ½-in. carbons than the $\frac{7}{16}$; the lamp No. 3, using the latter, gave no better regulation than the one with the ½-in. carbon.

Life Tests.

The life of a lamp for one trimming depends on a large number of conditions, most of which are self-evident.

1. It is influenced by the size and quality of the carbons. The carbons will not run exactly the proper diameter, even though of the same make. This, while hardly noticeable to the eye, is discovered when it is found impossible to slip the carbon through the gas cap or in the lower socket and hole through the bottom.

2. The life depends upon the current strength. This varies gradually during the run of the lamp, on account of the plunger, caused by the wasting of the upper carbon. The following figures will give an idea of this change :

With upper carbon, full length of 12 in. current taken by lamp was 5.2 amperes. Carbon 9-in. long, the current was only 5.05 amperes; while, when carbon was only 6-ins. long, its final length, current was 4.85 amperes.

3. The size of the enclosing globe affects the life, it being less by a slight amount for a smaller globe. With the same conditions otherwise, a lamp having a small globe will, during a given run, have this globe replenished with air from the outside oftener than a larger globe.

Table VI. gives the carbon consumption in inches per hour for 5-in. and 6-in. globes.

TABLE VI.

Consumption.	5-in. Globe.	6-in. Globe.
Positive	.067	.0687
Negative	.034	.029
Total	.101	.0977

4. The rate of consumption of carbon varies with the height of the arc in the globe. Although the current decreases in value as the upper carbon is consumed, the total consumption per hour is increased as the position of the arc goes downward in the globe. The measurements given below, in Table VII, show this, which is a result of the increased circulation caused by the heat of the arc being lower in the bulb.

TABLE VII.

Position of Arc in Bulb	Positive.	Negative.	Total.
Top	.070	.024	.094
Middle	.074	.034	.108
Bottom	.079	.039	.118

At the middle of the bulb the consumption per hour is 14 per cent. greater than at the top; at the bottom it is 25 per cent. greater. These figures are for $\frac{7}{16}$-inch carbons, and are the largest for any of the lamps tested.

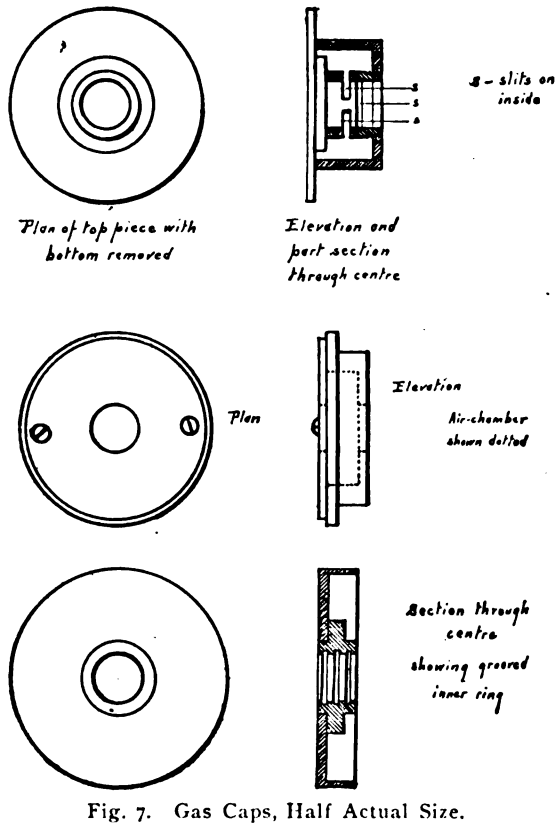

Fig. 7. Gas Caps, Half Actual Size.

5. The form of gas plug used also influences the life. They vary in form from a simple circular plate with the hole for the carbon grooved in two circles parallel with the plane of the disk, to the arrangement having a chamber fitted with slits through that wall which is next the carbon. The object of this chamber is to obstruct the circulation as much as possible, and yet have sufficient air to keep the carbon from depositing on the globe in excessive quantities. For some reason the consumption of negative and positive in one of the lamps having this latter form of cap is in the proportion of from 1 : 5 to 1 : 10. In all the other lamps the ratio of consumption of positive and negative carbons varied from 1.7 : to 2.9 : 1. Since a slow consumption of the negative carbon keeps the arc well up in the globe, it gives an advantage over the other lamps in producing a larger area of distribution of light at the end of the run. On a horizontal plane it will give a little less, as the coating is heavier at the top of the globe. This holds, however, for a continuous run only; the ratio of consumption being 1 : 3 for intermittent runs. This shows how the effect of the gas cap is neutralized by allowing fresh air to enter at intervals.

Fig. 7 shows the different styles of caps.

6. Whether the run is continuous or intermittent will make a difference in the life, although only slight. Theo-

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THE EROSION OF METALWORK BY STRAY CURRENTS.

A great question is being agitated by certain electrical engineers in the daily papers regarding the gradual erosion of metal work, exposed to the influence of stray currents. Being of vital importance to those living in large cities, because of the great network of underground conductors laid there, an extensive system of electric roads operating in their midst, investigation has taken such a turn that the question is now about to be considered: whether electrolysis is destroying the cities' water-pipes, attacking the foundation of large structures or creating havoc at places of public interest? The means of judging whether this actually occurs or not, is a simple and practical one. The general proposition may be stated that any metallic body will be eroded if it acts as the outlet for a current, however light. In other words, a metal object positive with reference to the earth is gradually losing, day by day, a collection of infinitesimal particles, which in the course of months and years will invite serious consequences. The data supplying all necessary information may be found in any treatise on electroplating. The pressure required for the disintegration of iron varies from one to three volts. The stray currents leaking from ground returns and underground conductors and meeting in their transit water-pipes, etc., do certainly have an injurious effect in many cases upon the integrity of the water-supply system. To remove so mischievous an effect, a course must be decided upon that will sweep away influence inimical to the well-being of any earth-covered support or pipe. The cry has usually arisen in places where the trolley system predominates. It certainly lies in the power of traction companies to remove this crying evil, whenever it exists. If the current cannot find an easy path through the rails and bonds connecting thereto it will divide up according to Ohm's law, and mingle with the earth whenever the resistance of a bond is high enough to invite that condition. An earth return should be so perfect a circuit, theoretically, that if the tracks composing it were lifted off the ground, the drop in the system would not vary one per cent. The point is therefore this, that although the tracks rest upon the earth, it is not the intention of the traction company to depend upon it in any respect, and when leakage does occur from the tracks to earth, and in our present system such leakage is inevitable, it is due to some fault in construction, not a mistake but a lack of care which manifests itself in the form of stray currents, whose influence upon surrounding metal work is apt to be extremely injurious. It is not necessary to conclude, from what has been said, that in all cases poor bonding of tracks will create havoc, but this may be well remembered that in all cases where tracks are not well bonded the company is paying through the nose for its power and is running a very heavy chance of affecting the system of water-pipes in a large city. The recent discussion regarding the supporting cable terminals of Brooklyn Bridge may cause no dismay if it be known that the masonry to which they have been fastened is dry and practically free from conductivity. The myriads crossing the bridge may indeed fear if the self-same supporting terminals are held by damp stones, impregnated with moisture and seamed with stains of iron that owe their origin to the gradual decay of the vital parts of that great structure.

THE FINAL SYSTEM OF ELECTRIC TRACTION.

One of the greatest of English engineers on visiting this country a few months ago expressed his opinion on the subject of electric traction by saying that he believed the only successful electric traction system would be one of an automatic nature; that is to say, a block system. Perhaps the importance of this fact is already appreciated by our well-known engineers; if not, it should be Leakage is suppressed largely and the value of the system greatly increased in consequence of the removal of so many objectionable features, that both the engineering and the financial world should greet a well constructed, simple and efficient block system with every evidence of satisfaction. Certain great changes are imminent in every department of steam and of electrical engineering. One of those, heralded by many signs, is that of an automatic electric block system. It is merely one in which the current is thrown into that section of rail beneath the car, and cut out as the car proceeds. It is one which must have a switch that will not arc and a system devoid of complications, either as regards the operation of this automatic switch, or the means of preventing arcing when its functions have been performed. The system described in this issue, representing the invention of Capt. McLeod Murphy, satisfies the above conditions in every respect. He has carefully studied the situation and designed the mechanism of a road which, in practical operation, will meet with assured success.

Bobcaygeon, Ont.—Much interest is taken in the proposition to build an electric railway betweeen this city and Peterboro. The scheme is to build a line to Scott's Mills, some twelve miles east, thence to Buckborn and Peterboro. The cost is estimated at $200,000.

Woodstock, Ont.—We are informed that no company has been formed to build an electric railway between here and Ingersoll. The franchise for the City of Woodstock is held by the Woodstock Electric Light, Power and Street-Railway Company, who have tried to interest parties in the building of the road, but so far without success.

J. Alcide Chaussé.

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retically, the life should be less for the intermittent test than when the lamp is kept burning without any stops. The stoppage allows fresh air to get in, thus increasing the consumption. When the current is thrown off a lamp, it is to be noticed that the CO gas catches fire from the inrush of air and forces its way out against the incoming currents, so that in some instances the force is sufficient to make the cap chatter in its place. This blue flame disappears in a time varying up to ten seconds. The results we obtained were irregular, but show that the life is about the same whether the lamp is burning steadily or at intervals, as shown by table VIII.

TABLE VIII.

Test.	Steady Run. Life in Hours.	Intermittent Run. Life in Hours.	No. of Stops.
a	124	128	21
b	130	143	15
c	28	25.5	22
d		143	15
		141	20
e	128	112	18

consume carbon as if it had burned continuously for 145 hours.

7. Some of the lamps make use of an air-tight outer globe to keep down the supply of air. This may make a slight difference in the lamp's life, but it has the disadvantage of raising the temperature inside the lamp to a very high point, making it necessary to use an insulation that will not char from the effect of the heat. It may also cause a coating of shellac that is originally put on the solenoid to deposit on the brass rod, insulating it and causing it to stick. A thermometer placed inside the extra resistance in a lamp that was open at the top, showed 324° F. The temperature of the air around the clutch in a lamp with ventilating hole was 280° F., and that of the shell, 134° F. The inside temperature of a tightly closed lamp would probably be considerably higher.

Ratio of Consumption of Positive and Negative Carbons.

For a given lamp, the ratio decreases as the total rate of consumption increases, both for different sizes of globes and for different parts of the same globe. This is shown by Fig. 8 and table IX.

TABLE IX.

Consumption in Inches per Hour.			Ratio.	Remarks
Positive.	Negative.	Total.		
.070	.024	.094	2.97	Different parts of same globe.
.074	.034	.108	2.20	
.079	.039	.118	2.02	
.0687	.029	.0977	2.37	Different globes.
.0670	.034	.101	1.97	
.0617	.00617	.0678	10.	$\frac{7}{16}$" carbons largest ratio observed.
.0509	.0227	.0736	2.24	$\frac{1}{2}$" carbons
.0467	.0216	.0673	2.16	
.0543	.0217	.076	2.50	
.046	.027	.073	1.70	
.048	.023	.071	2.08	

Test c is not the full life. An accident compelled the stoppage of the continuous test after 28 hours and the intermittent test was then carried on till the same amount of carbon had been consumed. It will be observed that in two cases the life was longer for the non-continuous run. Another test not given above showed almost exactly the same loss of carbon for each test, the consumption for a given number of hours being measured.

To find theoretically the amount of carbon consumed with intermittent use, we can calculate the weight of oxygen the bulb contains when filled with fresh air, and from this determine the amount of carbon burned before the admission of any more fresh air. For example, one of the bulbs contained 18.8 cubic inches of air. Since the amount of oxygen contained is one-fifth of this, and a cubic inch weighs 343 grains, the bulb contains when filled with fresh air 129 grains of oxygen. In forming CO gas, this amount of oxygen would require .967 grain, or approximately one grain of carbon to combine with. Carbon at a specific gravity of 20 weighs 505 grains per cubic inch. If the carbon is ½ inch in diameter, its section is very nearly 2 sq. in., and a piece one inch long will have a volume of about .2 cu. in. and weigh approximately 100 grains. Then, if one grain of carbon is consumed for each filling of the bulb, it means that .01 in. in length has been used. Taking .07 in. as an average total consumption per hour and only .01 inch is consumed by the air in the bulb at starting, it will take 7 of these renewals to consume an amount of carbon equal to one hour's regular run. That is, if the lamp is run for a few minutes, sufficient theoretically to exhaust the oxygen in the bulb, and if this is done 7 times, it will use as much carbon as if the lamp had been running steadily for one hour. Therefore, taking 4 hours as an average run, a lamp burning 140 hours would have 35 stops, equivalent in consumption to 5 hours run, and on this basis would

It will be observed that the smallest total consumption was obtained with a $\frac{7}{16}$ inch carbon, showing very markedly the effect of the gas cap. The usual method of renewing the carbons is to use the remainder of the upper carbon for the negative in the next run. In the case of the lamp just cited (No. 3) the upper carbon left is about ½ in. shorter than a new lower carbon, but since the life of this lamp is so prolonged the shortness would be no drawback. The lower carbon might even be used for two continuous runs, if the position of the arc in the lower portion of the globe is not objectionable.

The long life of the enclosed arc may be considered its chief advantage over the ordinary open arc, the saving in carbons and trimmers' expenses being very large. The old style of lamp requires two carbons for each trimming, and lasts 6 or 8 hours. The enclosed arc requires to be trimmed about $\frac{1}{16}$ or $\frac{1}{20}$ as often. Furthermore, each re-trimming costs less. For, although the cost per thousand for the same size carbon is greater for the enclosed arc, being $23, for 12 in. × $\frac{7}{16}$ in. rods only one is required for re-trimming, while the open arc needs two 12 in. × $\frac{7}{16}$ rods costing $18.70 per thousand and 6 in. × $\frac{7}{16}$ rods costing $8.30; so that one thousand re-trimmings cost $23 for the enclosed lamp, against $27 for the open lamp, or a saving of $4 per thousand trimmings in favor of the enclosed arc lamp.

AFTER January 1, 1898, A. C. Jahl will not be connected with Mr. G. Humbrock, the manufacturers' agent, 39–41 Cortlandt street, New York City. Mr. Humbrock handles all kinds of electric light and railway supplies.

Coburg, Ont.—The town will apply to the Legislature at its next session for the power to construct electric-light plants.

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A BUSINESS NEED SUPPLIED.

There are few practical men of business who do not recognize the benefit of advertising in hunting for new and holding old trade. That many fail to show a proper appreciation of this fact by keeping alive an up-to-date and representative line of advertising is largely because to do so requires more time and attention than is available where those who must be entrusted with the work have already more than enough to occupy them. The need, too, of a master mind is an essential that is more than likely wanting in most instances.

Not all of those who find themselves thus situated are aware that there is in existence in New York City a concern whose business it is to supply to manufacturers the time and attention necessary for the efficient and profitable management of the advertising end of a business.

The Manufacturers' Advertising Bureau, 126 Liberty street, New York, is a business need supplied. With the testimony of many of the largest and most prominent manufacturers at hand to back up the statement, we can say it is a thoroughly advantageous business connection for the progressive but pressed-for-time advertiser of to-day.

The firm that places its newspaper work and advertising in the charge of the Bureau will be relieved of the many vexatious, time-taking, but nevertheless necessary details that combine to make advertising pay, and will at the same time have the benefit of twenty years' experience in trade journal advertising.

Benj. R. Western, the proprietor of the Bureau, is a thorough newspaper man of extensive experience in trade journal advertising. He has associated with him in the conduct of his business a corps of able assistants, qualified by experience to further in every way the interests of the clients of the Bureau.

The methods of the concern are such as the times demand. Their clients are well served and the number, we are pleased to note, is increasing every year.

A little business book, bearing the title "Advertising for Profit," is issued by the Manufacturers' Advertising Bureau, and tells in a brief, busy man's way how Mr. Western and his associates work. Copies, we are informed, can be obtained gratis upon application and a business card.

RAILWAY INCANDESCENT LAMPS.

The important feature in lamps intended for use on railway circuits is long life without decrease in brilliancy. To secure this both mechanical strength and uniformity of product are essential. Railway lamps should be uniform not only in size, shape and appearance, but absolutely so in current consumption. Both length of life and sustained candle-power depend upon such uniformity, and while the former is the most desirable characteristic, it should not be forgotten that lamps are primarily made to give light. Practically any length of life can be secured in lamps of low efficiency—lamps consuming a large amount of power; but power is not had for nothing, and while one lamp may last longer than another, it may consume so much current as to make it cost more than a lamp of shorter life, and yet be so dim as to make it worthless, consuming current without giving a proper return in life. The ideal lamp, therefore, is that on which the average life is combined with average candle-power and energy consumed to give the best lighting service for the least cost, including lamp renewals and power consumed.

In the Edison Railway Incandescent Lamp the results

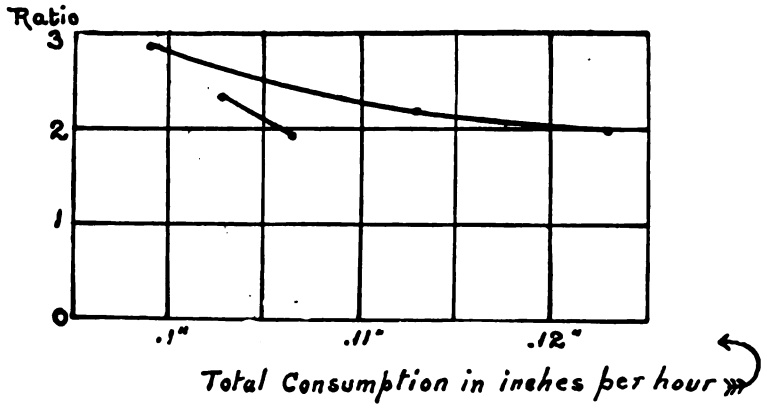

Fig. 8. See p. 8.

above are obtained first, by its mechanical strength, the filament, of cellulose with a hard graphitic carbon coating, being so shaped and anchored as to protect it as well the bulb from injuries likely to occur from the vibration and shock inseparable from street-car service. The anchoring of the filament is essential. An unanchored filament must necessarily be so stiff and short as to limit the light to a small area. This reduces both the efficiency and sustained brilliancy of the lamp. The position of the anchor is also of importance. To anchor the lower end of the filament to the inside of the bulb is objectionable. The filament is held too rigidly, exposing both it and the anchor to rupture in case of jar or shock. Rigidity can be eliminated by loosely resting the filament in the loop of the anchor, but the friction of the filament in the loop quickly wears it away. In the Edison lamp the anchor is set in the stem and the vibration of the filament is rather checked than entirely prevented. It is thus not strained nor weakened, as both filament and anchor vibrate together, and no chance exists of the branches interlocking and short-circuiting, as would probably be the case if one loop of the filament were anchored to the side of the bulb and the other left free to vibrate and strike against it.

As railway lamps are operated in series the current capacity should be uniform. Edison railway lamps are, therefore, made in three different classes—for 500-volt circuits, for 550-volt circuits and for 600-volt circuits, in each class the lamp being selected for a given amperage. The standard railway lamps have an efficiency of four watts per candle at full 16 candle-power. They are fitted with the standard Edison screw base, or with bases to fit almost any make of socket.

For the decoration of cars or for headlights, or special locations in which a small compact bulb is required, the round bulb lamp is manufactured. Its filament is shaped and anchored as is the standard railway lamp, and both are furnished frosted or of almost any desirable color—either artificially dipped or in natural glass.

The best lamp can be so misused as tc render it worthless, while by proper use the maximum of life and light is

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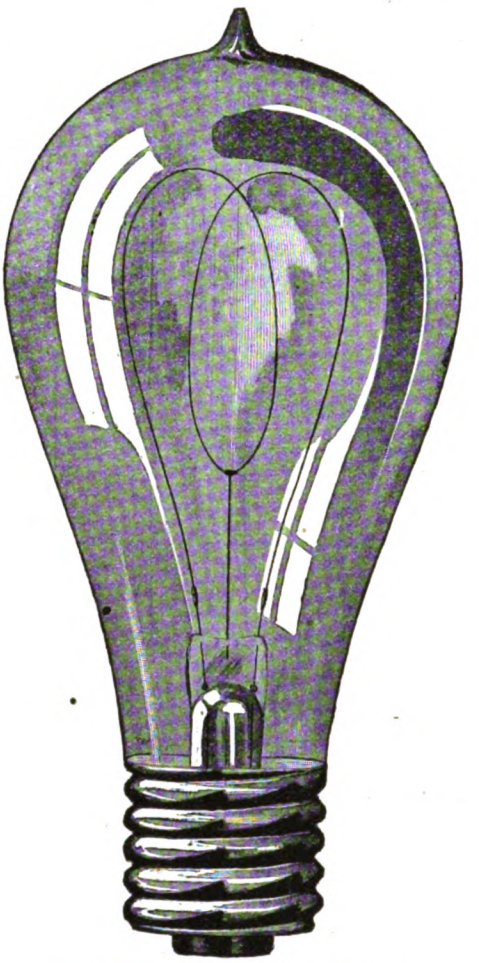
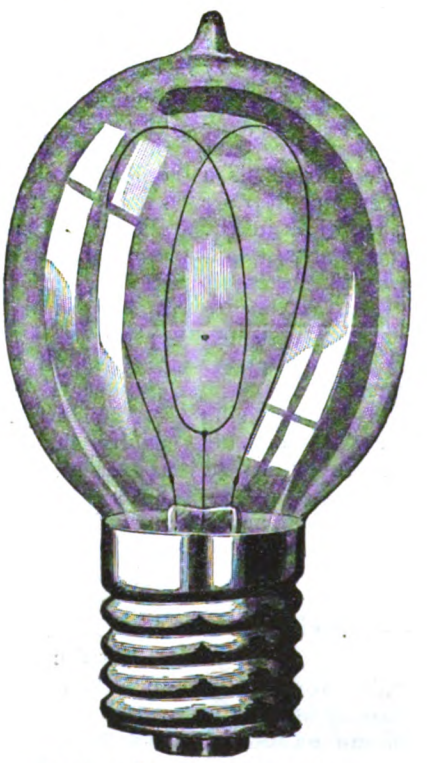
obtained. Proper use demands that the same amperage and make in lamps be used on the same car or series; that they be ordered to suit the total voltage of the circuit, and that the lamps which have become dim from age be at once replaced by new ones; and this last requirement is necessary if light is to be economically produced.



General Electric Railway Lamp.



General Electric Railway Lamp.

Winnipeg, Man.—It has been decided to invite tenders for electric street lighting for a period of three to five years from April 25, 1898.

Brantford, Ont.—Brantford is making estimates on an electric-lighting plant. The present contract will expire next year.

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THE MEASUREMENT OF CURRENT.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

Electro-Thermal.—If the extent to which a metallic wire stretches when heated be determined by experiment, the term "coefficient of expansion" clearly defines such an effect, if referred to as the increase in length per foot, or even the percentage of increase over all.

A current passing through a wire heats it, although not in direct proportion to the current. If the current is one ampere and the heat be measured, by increasing the current to two amperes the heat becomes four times as great. This is due to the fact that the heat does not depend directly upon the current, but upon C × C, or the square of the current. With a current of three amperes the heat becomes 3× 3, or nine times as great, etc.

If a wire carrying a current exercise its expansion or contraction upon a hand or pointer placed before a dial, the wire passing over a little wheel attached to it, and a spiral spring hold the pointer at zero when no current passes, the wire would expand when the current flowed through, the spring would gather in the slack wire, and by doing so move the pointer, thus indicating a current. The elements of an electro-thermal instrument are contained in this illustration.

Prof. Forbes, of England, invented an electro-thermal instrument in which a coil of high-resistance metal, being heated by the passage of a current, caused a small windmill with mica blades to rotate.

The current would affect the velocity of the prime mover by the least variation, but its extreme delicacy forbade its use as a practical instrument. This instrument might more properly be classed under the head of recording ammeters, as that was its evident object. There are other types of instruments which record both current and pressure, but the principle of their action is not thermal, and they cannot be included here. Hot-wire instruments or their equivalent have fallen into disuse of late, because of the greater accuracy and more attainable perfection of electro-magnetic devices.

Electro-Magnetic. — Electro-magnetic instruments depend for their current-measuring properties upon the relation existing between a current and the magnetic effects that follow from it. Although the methods of measurement employed under this head are very numerous, the means by which effects are produced may be briefly stated :

(1) A coil carrying a current affects a movable magnet.
(2) A magnet affects a movable coil.
(3) A coil affects a movable coil.

Practically all the devices of the above order, with the exception of the last, might be termed galvanometers.

For the absolute measurement of current the galvanometers of the following order come into prominence; they belong to the first order :

A stationary coil and a movable magnetic needle :

(a) Tangent galvanometer.
(b) Sine galvanometer.

A most unique type belonging to the second class was invented by M. D'Arsonval, with an immovable magnet and a movable coil. The famous Weston instruments act on the basis of this principle.

Under the head of the third class—a stationary coil actuating a movable coil—both of the following are practically dynamometers:

(c) Dynamometer.
(d) Ampere balance.

An intermediate and very common form of current indicator consists of a coil whose entire function is the attraction of a soft iron core. As the extent of the attraction depends upon the current, the movement of the core after the proper attachment to a pointer has been made may be marked on a dial and thus used for future reference.

The process of calibration is adopted with such devices, that is to say, the use of currents whose strength is varied and successive values known and recorded on the hitherto unmarked dial. The Edison Company employed this form of instrument, which is generally known as the Bergmann ammeter.

The tangent galvanometer is composed of a coil of large diameter, more aptly designated as a narrow reel. At the centre is a pivoted magnetic needle above a circular dial marked in degrees. The currents passed into the instrument cause different angular deflections. The currents are not proportional to the angles themselves, because by doubling the current the deflection is not increased twice. The currents, however, are proportional to the tangents of the angles. Triple the current will swing the needle around to an angle whose tangent is three times that of the previous angle. A value termed the constant of the galvanometer is found and the current calculated by the rule—

current = constant × tangent of angle of deflection.

The constant is obtained by sending in a known current —observing the deflection—and its tangent is obtained. The constant which can be used for all future cases is

$$\text{constant} = \frac{\text{current}}{\text{tangent of angle of deflection.}}$$

A sine galvanometer works on an equally simple principle, the current being proportional to the sine of the angle of deflection—the rule being

current = constant × sine of angle of deflection:

the constant is a quantity determined in a similar manner for practical use.

The D'Arsonval galvanometer has a permanent steel magnet with a coil suspended between its poles. A metal cylinder upon which the wire is wound gives to this instrument the peculiar and useful property of being dead beat.

The Weston ampere-meter, or ammeter as it is commonly called, with some slight changes is identical with the above. The coil in this instrument is suspended on pivots. A pair of watch-springs convey current to the coil and bring it back to zero when it ceases.

The springs do not lose their temper, because the entire current passes freely on through the instrument, while a slight portion required for the movement of the coil is shunted into it. The instrument is calibrated by passing known currents into it and the deflections marked on the dial. They are equal, and in ammeters of this particular construction accurate to within $\frac{1}{10}$ of one per cent. The springs unwind as the deflection increases and thus serve in part to equalize the deflections.

Dynamometers record readings which are proportional to the square of the current. A fixed coil is so situated that a coil in the same plane, both being of rectangular shape, is inclined by the effect of the current ; the movement of the inner coil acts upon a wire by which it is suspended and also moves the hand of a dial. To bring the coil back to its former position requires a twisting or torsional force, which must be applied to the wire. The current is proportional to the square root of this angle of torsion.

Recording ammeters of a somewhat expensive pattern have been produced by various inventors, but today it can hardly be said that there is really a single moderately cheap form of recording ammeter on the market. The Edison Illuminating Co. still adhere to the electro-chemi-

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cal method in their meters, and the prevalent types of ammeters that are called recording have failed to appeal to them. The hot-wire mica.vane instrument of Forbes and possibly a system of photographing a moving spot of light reflected from a mirror, employed by the Walker Co., are the few that utilize complex methods for that purpose.

A famous inventor and scientist suggested the use of a wheel of copper, immersed in a copper sulphate solution, for the purpose just described. The copper wheel being gradually loaded on one side with copper that has been plated on it would slowly rotate, and thus record the current consumed in the circuit. While the idea is ingenious, the practical development of it is full of difficulties.

A simple form of ammeter of sufficient accuracy to be depended upon, and an equally simple form for the actual recording of the current, would be of value and importance to those practically interested. Were it possible to suppress other phenomena, which invariably make their appearance when a current passes in a circuit, the decomposition of water might be utilized as a possible means by using its accumulated pressure for the movement of a mechanical system, which would record the volume of gas passing.

An ampere has been defined as the current which passes through a resistance of one ohm at a pressure of one volt.

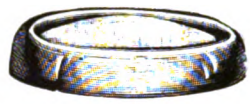
The true unit of current is based upon the absolute system of units sometimes called the C. G. S. system—the centimeter, gramme and second being the quantities involved.

If an arc of wire of one centimeter radius and one centimeter length be brought near a unit magnetic pole, if the unit pole be placed at the centre of a circle of which the wire is a part, it will be affected by the force of one dyne. A dyne is the unit of force developed by the unit of weight moving a unit of distance in a unit of time. As the units have been specified, the movement of one gramme a distance of one centimeter in one second brings into being one dyne.

The arc of wire producing such an effect will then be carrying a unit of current. This, however, is so large that the practical unit has been made one-tenth of it, and is called the ampere.

The electro-chemical method of determining the ampere has already been considered. The coulomb comes into direct consideration in this method, it being well known that the transference of a metal never varies in quantity when carried over by one coulomb. Whereas one coulomb of electricity will transfer a different weight of copper than iron, and a different weight of silver than gold, the amount of metal carried over by a coulomb for each particular metal never changes.

Certain fixed proportions always exist, and their immutability has been repeatedly tested without failure.



Pressnre Cup of Button.

$$\text{For Volume Voltmeter } C = \frac{v}{t \times .1734} \qquad \begin{array}{l} v = \text{cu. cms.} \\ t = \text{seconds.} \end{array}$$

Electro-Chemical Equivalents.

	Grammes per Coulomb.
Hydrogen	.00001035
Silver	.00118
Copper	.000326
Water	.00009315

Casing of Button.

F. A. Scheffler, M. E., sales agent of the Sterling Boiler, 126 Liberty Street, New York, will take the superintendence of the elevator department at the works of the Sprague Electric Co., Jan. 1.

AN IMPROVED MOISTURE-PROOF PUSH BUTTON.

In a recent issue of The Electrical Age a brief description was given of some important electrical specialties manufactured by Huebel & Manger, 286-290 Graham St., Brooklyn, N. Y. Those interested in annunciator and bell work have no doubt frequently experienced great difficulty in keeping push-button contacts clean, and, in fact, in protecting the push-button from moisture, which, getting into the connection, corrodes them and makes the push-button worthless. This is noticed in a marked degree in breweries, ice-houses, damp cellars or any place of like nature in which push-buttons must be installed. The illustrations show the parts of a push-button that is absolutely moisture proof and after

Contacts of Huebel & Manger Moisture Proof Button.

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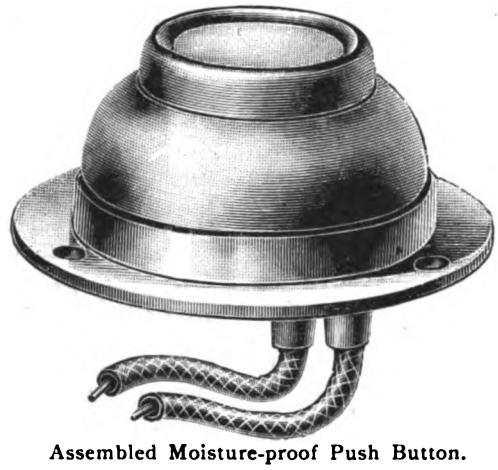
being installed will never develop the faults usually found in the ordinary style of button. It is shown assembled and in parts. Every portion is amply protected and if screwed tightly into place will last for years unaffected by external conditions. The above concern believe in common with their customers that no push-button on the market can equal this in practical use and feel sure that many of the difficulties experienced by bell-hangers will immediately disappear if this button is used instead of the cheap devices thrown promiscuously upon the market.



Assembled Moisture-proof Push Button.

They solicit correspondence and will send catalogues and descriptive matter to prospective purchasers.

THE BEST METHOD OF SETTLING DAMAGE CASES AND THE PREVENTION OF ACCIDENTS BY THE USE OF FENDERS OR OTHERWISE.

BY WILLIAM J. HIELD.

It is hard to handle, in a short paper, this most difficult subject which is today perplexing the officials of all large street-railway systems. However, as the study of these questions is made imperative by reason of their serious importance, I venture to offer a few ideas which I trust may prove of some interest, if not of value. Like all other professions, the law has in late years given rise to many specialists, among whom the personal-injury lawyer is most prominent to the street-railway manager. His untiring efforts have wrought such a change that the question of settling damage cases today is vastly different from what it was a few years ago. The general manager or superintendent can no longer personally adjust the claims against his road, but must employ men for that particular purpose. It is now necssary for him to have a claim department, the system of which should be perfect in detail and work, and work in true harmony with his operating department, both for the prevention of accidents and the settling or fighting of damage cases.

The secret of success in handling damage cases, lies, no doubt, in their being properly looked after from the start, i. e., from the time they are first reported. How to do this varies as do the different cases, but no case should ever be handled by anyone but an honest, careful and experienced claim agent. For such work men must be naturally qualified; they should ever have the interests of their road at heart and yet not be blinded by too great a prejudice in its favor; they should have sound, shrewd judgment and be painstaking and careful of detail to the highest degree. Like the true physician, they should be of a happy, calm temperament, and also like him, should ever be ready to answer a call. The successful claim agent should have the faculty of handling all sorts of people without friction. His keen perception should reveal to him the nature of each case, but he should never betray anxiety for settlement. Every claim department should have a good system for securing reports of accidents, for obtaining evidence, and for keeping such files and records as may be necessary for its work.

The only accidents which demand serious consideration are those in which personal injury is involved. These may be divided into the three following classes :

First. Those in which there is an undisputed liability and which, as a rule, should be settled as soon after their occurrence as possible.

Second. Those in whlch there is a doubtful liability, generally, and which, should be settled after careful investigation.

Third. Those in which there is clearly no liabililty and which should therefore never be settled.

Frequently cases may prove exceptions to these rules, but in handling them under such a classification or any other, the following suggestions would seem to be of importance.

First. It is of great value in every case to acquire a knowledge of it as early in its history as possible. Procrastination is ever dangerous and the claim agent should have for his motto,—"Time is the essence of success."

Second. Evidence should be carefully secured in every case soon after the accident. Too much can never be reported to the department, and what may seem of little importance at the time of the accident, may prove most valuable in preparing the case for trial.

Third. In nearly all unsettled cases (particularly in serious ones), an examination by one or more surgeons in behalf of the company is desirable.

Fourth. Assistance and kindly tender of services, immediately after a serious accident, are more in place than advances for settlement.

Fifth. Admission of the company's negligence is seldom necessary, but the true rights of the claiment should not be denied; as by antagonizing him all chances of settlement may be lost.

Sixth. Whenever possible, a sworn statement should be secured from the claimant, giving his history of the accident and stating as nearly as possible the damage done. Such an affidavit, carefully and truthfully drawn and signed before witnesses—who should also attest it —may often prove most valuable either in settling or fighting a case. By it the claims of the interested party are clearly defined and limited, so that any subsequent intention to change them may be checked.

Seventh. In every case the claim agent should be fair, but firm. Too cheap a settlement is not the best settlement, but one too expensive is quite as bad, and perhaps worse. However, the claim agent can generally keep the claimant good natured and insist upon his acknowledging that the settlement is a fair one at the time it is made, and thus prevent his feeling or talking ugly about it later.

Eighth. A full release of all claims should be taken from the claimant, and its contents explained to him fully.

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This is of great importance, as the validity of releases is often disputed, and it is then quite necessary to show that they were properly taken. On this account, it is best to explain the release to the claimant before witnesses (who should also attest it) or to make him acknowledge later before them that he executed it of his own free will, understanding its nature.

From these suggestions one may deduce that the method best adapted for the handling and settling of damage cases is to be prompt, thorough and careful, with a liberal use of sound common sense. Whether a case should be speedily settled, or not settled at all, is a matter which must be decided from the peculiar circumstances which it presents, and not by any fixed rule. As a general thing, however, it is well to settle all cases where the injured parties are inclined to be fair, according to the merit each case contains, and fight all cases in which the claimants are very unreasonable, or where fraud is apparent. This rule carried out with the right spirit will prove a valuable policy for any road. If a case be settled, let it be done with due consideration of justice, and if it be fought, let every effort be made to fight it in the fairest and most efficient way possible.

It is not usually desirable that the claim agent should make offers of settlement, but rather it is advisable for him to draw his man out and get him to state definitely, if possible, what sum he really thinks he should be paid. Generally, such a sum can be considerably cut down no matter what the case, but if it is not an unfair amount, in consideration of the injury, it should be paid. Seldom pay more to a lawyer than to the injured party himself, and do not settle a case simply because suit is threatened or commenced. Never settle out from under an attorney who has been professional and courteous in his relations to the road, yet when an unprincipled damage lawyer is interested in a case, do not hesitate to disregard him in settling it. When a good one to fight, the case should not be settled simply because it will cost less. It is ever well to remember, both that victories in court are a great benefit and that defeats are a great loss.

While as a strict matter of law it may not be correct, yet it is always well to give some consideration, when settling a case, to the circumstances of the injured party and allowing such personal interest to enter into the transaction as will not be inconsistent with good business. As a general thing, the claim agent should listen with apparent indifference to the claims of such persons as Jewish peddlers, loud talking and bulldozing men, sharp tongued women and all others whose claims have either the appearance of fraud or unreasonableness; with apparrent interest and sympathy to those other few cases which seem to merit it.

The gist of the foregoing may be expressed in these few words: have good claim agents of sound judgment, who will not settle cases by arbitrary rules, but who will rather consider them each in its peculiar details, weighing well the seriousness of the injury, the manner of the accident and hence the liability involved, as well as the circumstances of the claimant.

The old saying that "An ounce of prevention is worth a pound of cure" was never better applied than to the accident features of a modern street railway system. The rapid transit now in vogue upon the busy thoroughfares of our cities, whether by means of the trolley or the cable, has greatly increased the number of street railway accidents, and hence has caused the question "How to avoid them?" to be of very serious interest.

For this purpose the following points seem to be of particular interest:

1. It is very important for the prevention of accidents, as before stated, that the operating and claim departments work in perfect harmony and unison with each other to this end.

2. The employing of none but good men is most essential.

(To Be Continued.)

TO MAKE AN INTELLIGENT SELECTION from among the beautiful calendars we have received up to date would require the judgment of a Paris, but after carefully inspecting them, we have selected the following three calendars, and leave it to the electrical fraternity to decide which one is worthy of the most commendation.

William A. Rosenbaum, E. E., the well-known patent attorney and expert, of the Times Building, New York City, presents a calendar depicting a pastoral scene entitled "A Cool Retreat," a glimpse of which will be like balm to the busy business man. This calendar is certainly a work of art and will be appreciated by all lovers of nature.

The American Electrical Works, Providence, R. I., show a view of their extensive electric wire works at Phillipsdale, R. I., surrounded by an extremely tasty design. This calendar is printed in colors and makes a very artistic effect.

Cleverly Electrical Works, electrical supply makers, of 1018 Chestnut St., Philadelphia, Pa., show an "Old New England Mill," which for tone and fidelity to nature can hardly be equalled. Some people think Philadelphia slow; but Friend Cleverly does not show it.

We have received a beautiful 1898 Calendar from the Shultz Belting Co,, and take pleasure in stating that a copy will be mailed free to anyone accompanying their request with a three cent postage stamp to A. B. Laurence, Manager, Shultz Belting Co., 113 Liberty Street, New York; Shultz Belting Co., Boston, or the Shultz Belting Co., Philadelphia.

H. C. RICHARDS, Esq., representative of the Safety Insulated Wire & Cable Co., N. Y., says our Dec. 25 issue was a fine number, and congratulates us on the great advance made in the publication of the Electrical Age.

MR. C. P. GEDDES for a number of years has been treasurer of the Interior Conduit and Insulation Co., of New York. At a meeting of the directors of the Sprague Electric Co., of 20 and 22 Broad street, New York, last week, Mr. Geddes was elected assistant treasurer of the company. We are pleased to know that Mr. Geddes has received this high and responsible office, and we can congratulate the company upon the selection of so careful and conscientious a worker. We know that Mr. Geddes will keep a constant watch on the treasury of the company, and with the ability he has shown in the past, the treasury will never lack for funds.

ADAMS & BAGNALL ARC LAMPS, in Red and Blue Globes, were used in the illumination of the New York City Hall and Park on New Year's Eve during the Greater New York celebration.

WESTON STANDARD ILLUMINATED DIAL STATION INSTRUMENTS.

THESE INSTRUMENTS are based upon the same general principle and are just as accurate as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger, and the working parts are inclosed in a neatly designed dust-proof cast-iron case, which effectively shields the instruments from disturbing influences of external magnetic fields.

WESTON ELECTRICAL INSTRUMENT CO.

114-120 William St., Newark, N. J., U. S. A.

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The Electrical Age.

VOL. XXI—No. 2 NEW YORK, JANUARY 8, 1898 WHOLE No. 556

Fig. 1—General Electric Company's Locomotive, Hoboken Shore Road, Hoboken, N. J.

ELECTRICITY FOR SWITCHING PURPOSES ON THE HOBOKEN SHORE ROAD.

The use of electricity for switching purposes on the steam railroad, in place of the noisy drill steam engine, takes another step forward. This time on the Hoboken Shore Road, Hoboken, N. J. The full name of this road is the Hoboken Railroad Warehoase & Steamship Connecting Co. It runs from 17th street, Weehawken, to 4th street, Hoboken, along the water front, or from the Erie tracks at Weehawken to the docks of the North German Lloyd Steamship Co., Hoboken, a distance of about two miles.

This road was opened for traffic on September 20th, 1897. It was constructed to provide connecting facilities betweeu the tracks of the railroad companies entering Hoboken and the numerous warehouses and docks which line the west side of the North River from Hoboken to Weehauken. It is double track over a private right of way from 17th to 14th street, single track down Hudson street to 11th street and double track along that River Walk to 4th street, Hoboken.

The switching of the cars for the past three months has been effected by a repair car of the Hudson County Electric Railroad Company. The new locomotive was put into regular service on the 4th of January, 1898, hauling trains of loaded and empty freight cars between the docks and the Erie track. The difference in its operation from that of the common drill engine is immediately noticeable. The electric locomotive responds instantaneously to the movement of the controller handle and starts without jerk or noise, tightening up the couplings uniformly or coupling the cars together so gently that no blow is perceptible.

The locomotive was constructed in the shops of the General Electric Company, at Schenectady, N. Y., and somewhat resembles in appearance the electric locomotive in use on the Manufacturers' Railroad, which connects with the N. Y., N. H. & H. R. R. tracks at New Haven, Conn., and the giant locomotives now handling the entire freight traffic of the Baltimore & Ohio Railroad, through the Belt Line Tunnel at Baltimore. It is mounted on two four-wheel trucks, each axle carrying a G. E. 2000 motor, giving the locomotive a total of 540 rated H.P. The weight on the drivers is 57,200 pounds; the draw-bar pull is 10,000 lbs. The locomotive is driven through a single reduction gear of very low ratio. The speed is correspondingly low, and is rated at 8 miles an hour when hauling a heavy load.

At each end of the locomotive is an automatic coupler, and a small railed platform for the brakeman in charge of the trolley pole. The cab is of iron and resembles a double steam locomotive cab, with a sloping tender shield at each end. Drop windows are set around the four sides of the cab, affording an unobstructed view in all directions to the motorman. A sliding door on each side gives admission to the locomotive. The interior of the cab is lined with cherry and is a spacious and well lighted room. The fittings are all of polished brass or nickel. On each shield is a head-light; in addition one shield carries a bell, the other a chime whistle. Beneath one of the shields are four packed card resistances, two sand boxes, the compressed air tank and the equalizing air tank; beneather the other, eight resistances, two sand boxes and the engineer's tool box. At one end of the cab is placed a controller of the series parallel type known as the L-2. It contains, of course, the magnetic blow-out and is arranged to operate the motors either four in series or each two in series-multiple. Beside the controller is the air-brake handle and the two valves of the sanding arrangement, by means of which the sand is blown by the compressed air under the wheels.

In front of the motorman is an air-brake gauge and above it an ammeter reading to 500 amperes. Fastened to the roof of the cab is an L automatic circuit breaker

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set at 500 amperes. On the other side of the controller, from the motorman, is an M circuit breaker and an automatic governor switch for the air pump, placed at the other end of the cab. This is a single cylinder pump driven by a 3 H.-P. iron-clad bipolar slow speed motor.

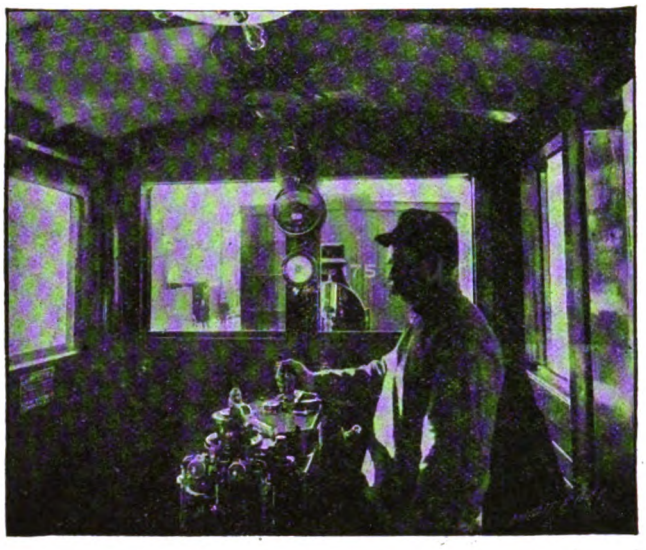

Fig. 2—Interior of Cab.

The operation of this air pump is automatic. When the air in the tanks is at normal pressure the governor switch is opened. Blowing the whistle, applying the brakes or using the sander causes the pressure to fall. This closes the switch automatically and starts the motor and pump.

The cab is lighted by five standard Edison railway incandescent lamps.

The overhead wire is 00, suspended from wires strung between octagonal cedar poles, except at two or three points, where bracket construction is used. Where the locomotive turns in from Hudson avenue to the River Walk, a peculiar condition has caused a special method of bracket construction. It was necessary for the overhead lie to be so set as not to infringe upon the limit of the next property. Thus at this point the overhead line is suspended from two bracket arms, one 6 ft. and the other 18 ft. long.

The current for the road is taken from the station of the Hudson Electric Light Co.

The Hudson Shore Road is one of the sub-companies of the Hudson Land & Improvement Company organized 52 years ago, under a special charter, by the Stevens family to consolidate their interests in their several Hoboken properties. The present head of the Stevens family, Col. Stevens, is president, and Robert L. and Richard Stevens are respectively first and second vice-presidents; the general manager and treasurer is Palmer Campbell, and the secretary, W. A. Macey.

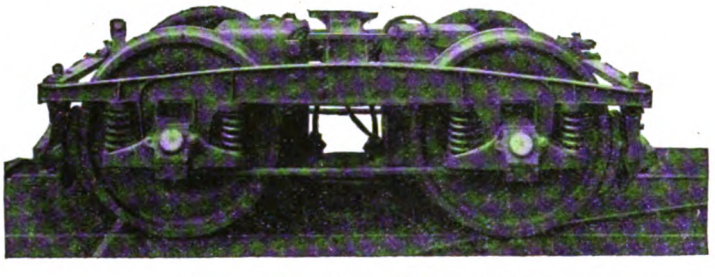

Fig. 3—Side View of One Truck.

Hamilton, Ont.—A gentleman has made a proposition to the city council to build an electric railway between this city and Caledonia.

The Hamilton, Chedoke and Ancaster Railway Company are making a vigorous effort to dispose of the balance of the stock, and hope to commence operations at an early date.

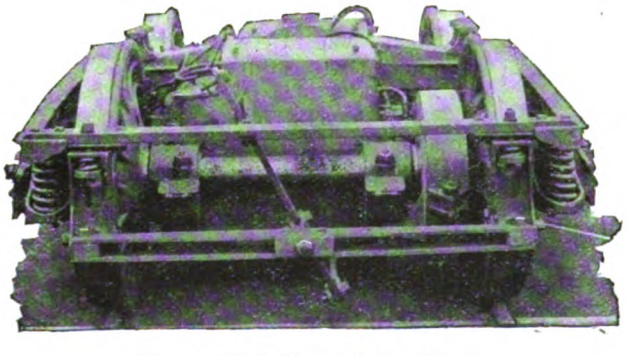

Fig. 4—End View of One Truck.

Lachute, Que.—The Atlantic and Lake Superior Railway Company, who own the Lachute and St. Andrews Railway, intend to convert it into an electric line and to extend it to Carillon.

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HISTORICAL SKETCH OF THE FIRE ALARM TELEGRAPH.

(Continued from page 360.)

One of the most effective remedies proposed for preventing the interference of signals is the system of interlaced circuits, for which J. N. Gamewell received a patent in 1875. In carrying out this method the circuits are run in such a way that no two adjacent boxes are on the same circuit. This is most easy of accomplishment in cities occupying a long but narrow territory. In cities less favorably situated the great amount of wire required to fully carry out this principle has been a bar to its general adoption. An additional advantage derived from interlaced circuits is this, that in case of an open circuit no two adjacent boxes will be out of service at the same time.

If two signal boxes of the non-interference type are pulled about the same time, the one that has precedence by as much as the fraction of a second will transmit its signal while the other will be inoperative. To prevent the loss of this signal, John J. Ruddick invented a signal box in which this is accomplished in a very ingenious manner. With these boxes in circuit any number may be pulled at the same time, and all will respond successively. While this would be an advantage in the extremely rare cases where two boxes on the same circuit are pulled at the same time for two different fires, it would be a positive disadvantage in all other cases where a number of boxes are pulled for the same fire, to have the circuit occupied transmitting unnecessary signals, should the firemen upon their arrival at the fire find a special call or a second alarm necessary.

A problem which has not received an altogether satisfactory solution is how to make the signal boxes readily accessible to anyone in case of fire, and in a way that will not at the same time render it easy to give false alarms.

For this purpose a keyless door on fire-alarm boxes has been somewhat extensively used in the larger cities; these doors are simply closed by a latch and opened by a handle. On turning the handle to open the box, a concealed gong starts to ring loudly and thus attracts attention; this device answers very well for a densely populated section of a city, but in the sparsely populated portions its benefit is not so apparent. Many cases are also on record where persons who opened such doors with the intention of sending in an alarm, failed to pull the hook, being under the impression that the striking of the gong was an indication that the signal was being transmitted.

Other methods, such as placing the key in a small box with a glass front easily broken, and located conveniently to the signal box, or over the keyhole with the key permanently inserted therein, have been tried with more or less success.

A traplock on the doors of signal boxes with keys numbered and the holder's name registered, and where consequently a key in the hands of a malicious person can be used but once, has been found very effective in reducing the frequency of false alarms.

In one of the most original plans proposed, the boxes are placed inside of booths with mechanism so devised that, upon pulling the hook, the door of the booth will close and hold the person giving the alarm a prisoner until released by the proper authorities.

In another invention, for which a patent was issued, the booth was dispensed with, but instead, the box was provided with hidden mechanism which when released by pulling the hook would firmly clasp and hold the wrist of the person sending the alarm. For reasons obvious to everyone but the inventors neither of these inventions ever found its way into public use.

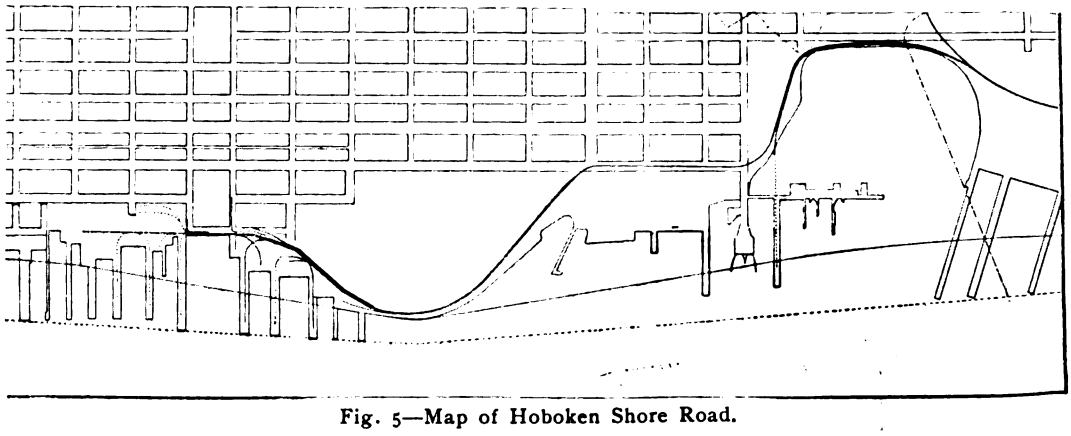

Fig. 5—Map of Hoboken Shore Road.

A not inconsiderable share of the unreliabilty of the fire-alarm telegraph in its earliest stages must be ascribed to the source which supplied the electrical energy. The Grove cell then used was not well adapted for service on a fire-alarm telegraph, where uniformity of current strength is such an essential requirement. The Daniel cell, by which it was succeeded, was much more satisfactory, and was generally employed up to the year 1871, when the Callaud or gravity cell was introduced. The superior merits of this cell were soon recognized, and in a very short time every fire-alarm telegraph was equipped with it. For over twenty years it was the only cell used for this service. Within the last two or three years, however, it has been superseded in a number of places by the storage battery, with very satisfactory results.

In one instance the gravity cell has been replaced by the dynamo. Superintendent Brown Flanders, of the Boston Fire-Alarm Telegraph, about five years ago applied the dynamo current to a single circuit. Its application was gradually extended, and at the present time the entire plant is operated by dynamos.

The automatic repeater invented by Edwin Rogers was gradually improved by him, as well as by the labors of J. N. Gamewell and Moses G. Crane, until it has become an apparatus of almost absolue reliability. While a signal from any one circuit attached to this repeater is being transmitted, all the other circuits are mechanically locked out, and thus confusion is prevented should a box on any other circuit be pulled at about the same time. It is also provided with a device whereby the armature of the operating electro-magnet is mechanically restored after each break of the circuit, and little more, therefore, is required of electricity than that it should hold the armature in position; consequently it will perform its functions successfully under greatly varying conditions of current strength, a very important consideration in an automatic system, where constant attention cannot be given to the care of the battery or the adjustment of the apparatus.

The electro-mechanical gongs have also been greatly improved, and nearly all are provided with armature-restoring devices, and for the use of fire departments, where the men are not permanently in their houses, they are provided with indicators which expose the number of the signal in large figures.

The general plan of a modern central office fire-alarm

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system still resembles that outlined by Dr. Channing, fifty-two years ago; but in the instruments and apparatus used most wonderful improvements have been made.

In the modern central office the Morse register has been replaced by the multiple pen register, which has the merit of greater compactness, and may accommodate both the signal and alarm circuits, with this advantage, that, as the records are printed in parallel lines on the same paper, their relative positions will indicate, to a second, the time elapsed between the reception of the signal from the box and its transmission to the engine-houses; it thus also incidentally serves as a record of the degree of promptness with which the operator has attended to his duties.

The old keyboard, at an early period, gave way to a dial transmitter still in use in several cities. In this apparatus there is a separate dial and index for every digit in the number to be transmitted. On receiving a signal from a box, the operator moves the indexes to the respective figures and starts the clockwork into action.

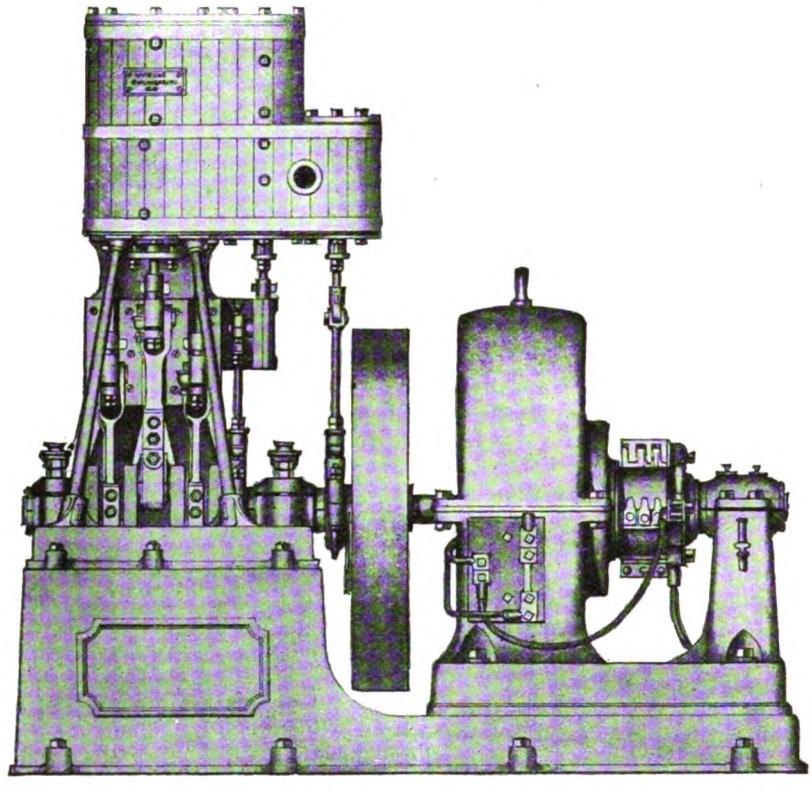
Another method, and one still in use in New York city, is to have a duplicate break-wheel for every signal-box number in the system. The operator, on receiving a signal of fire, selects the corresponding wheel and inserts it on the wheel shaft of the transmitter.

In one of the most improved modern transmitters the dials are all placed on the same shaft; the first dial on the shaft is stationary, and has engraved upon it the figures from one to nine, in as many series as there are movable dials; the other dials simply have apertures which in operation are turned so as to expose the numbers to be transmiited. This apparatus is manipulated with great rapidity, and as only the numbers to which the apparatus is set are exposed to view, the liability to error on the part of the operator is reduced to a minimum.

The testing clock of the original Boston central office has been succeeded by an automatic testing apparatus of excellent design and beautiful workmanship, which indicates and makes a record of the condition of the circuits at stated periods of time.

The best practice demands that there should be two separate circuits to communicate alarms from the central office to the engine houses, so that in case of trouble on one circuit the alarm may be received on the other.

In central offices equipped with new apparatus within the last few years every safeguard is provided to prevent mistakes in the transmission of alarms. With the first blow on the gong from a box signal a cylindrical indicator revolves and exposes the number of the circuit from which the signal is being received, as well as the number of every box on that circuit. The operator may, therefore, while counting the signal set the transmitter and, with one glance at the printed record of the register and another at the circuit indicator, verify its correctness and have the alarm in process of transmission within five seconds after the completion of the first round from the box.



Wells' Balanced Compound Engine and Bullock Generator.

WELLS' BALANCED COMPOUND AND QUADRUPLE EXPANSION ENGINE.

There is no field of desired improvement that has been more industriously worked within the past century than that of the steam engine. While its valve gear, material and workmanship have been vastly improved, the Wells system of the Wells Engine Company, 136 Liberty street, New York, represents the first and only improvement in its principle which justly entitles it to the distinction of being the most economical, durable and compact ever constructed. The important advantages derived from a balance of forces in the steam engine were practically unknown until demonstrated by this system, for the reason that all engines constructed with a "balance" in view embraced grave mechanical objections. Hence the single-acting "unbalanced reciprocating engine is the only system that has proved to be of any value. While the Wells engine embraces all of the desirable features of the most approved type in general use, it contains none of its objections. It is double-acting and so designed that all forces acting in the high-pressure cylinder are held in proper position by the forces acting in the low-pressure cylinder, producing a perfect balance around the crank-shaft, and preventing vibration and the escape or loss of power that in all other engines is thrown off through the frame into foundation.

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An important feature is the balancing of steam pressures, which is not contained in any other engine. Steam is admitted to both cylinders simultaneously; during the first stroke the steam pressures upon the middle cylinder-head are exerted against each other; the force acting upward in the high-pressure cylinder becomes the support of the force acting downward in the low-pressure cylinder. In the return-stroke the pressures are exerted upon the top and bottom cylinder-heads in opposite directions, giving a balance of pressures within the cylinders — a condition that applies to no other type of engine, as no strains are communicated to the frame and bed-plate.

The high and low-pressure pistons, with their connections, being equal in weight and attached to opposite ends of the levers, moving in opposite directions in the same plane, the thrust of one is perfectly counteracted by the other, permitting any speed without vibration, with minimum wear.

The force of the steam applied to the high-pressure piston descending upon one side of the shaft is balanced by the force of the steam applied to the low-pressure piston ascending upon the other side, leaving only the weight of the crank-shaft and its connections to be carried by the main bearing-boxes.

Each motion in this engine has a corresponding opposite motion, producing a perfect balance at all angles of the cranks, at all speeds. By this arrangement no strains escape from the cylinders, and the connecting rods and cranks become the sole transmitters and controllers of all outside forces. It also transfers the fulcrum from the main bearing boxes to the centre of the shaft, where the two forces are united and meet the resistance of the load. The weight and forces being equally applied to opposite crank-pins moving in opposite directions in the same plane, the cranks become the beams, or levers of balance, and there being no weight of parts to be lifted and no friction due to steam pressure to overcome, the steam forces applied to the pistons and the momentum forces stored in its moving parts ate all transformed into crank motion. Its absolute control of these forces for useful effect greatly increases the power of the engine. It also gives uniformity of motion, its forces being equal around the circuit of the shaft; they are given out in the crank-arms when the steam forces are diminishing as the pistons are approaching the end of the stroke, acting the same as an ordinary fly-wheel in carrying them over the centres, producing a rotary motion. While the weight and momentum of the reciprocating parts in all other engines retard the motion of the shaft and robs the engine of its power, by this method the motion of the shaft is accelerated.

Compared with the best "compound" engine in use, this principle shows in practice a gain of 25 per cent. in power, and as a simple "compound" it more than equals the economy of the best type of triple expansion.

Compared with the best type of compound engine in use it occupies one-half less space and is more simple, as it has one less frame, two main bearings in place of four, one-half less valve gear, and is one-third less weight; and compared to a triple expansion, which it more than equals in efficiency, the space occupied and its weight are still further reduced, while its simplicity is increased. Quadrupled it occupies no more space than the usual type of fore and aft compound, and is equally simple.

W. C. VOSBURGH MANUFACTURING CO., (Limited), manufacturers of gas and electric-light fixtures, 269 to 281 State street, Borough of Brooklyn, City of New York, N. Y., H. C. Beck, president. John Nix, vice-president; F. L. Strickland, treasurer; Chas. Chas. H. Littlefield, secretary. Western Branch: 114–116 Wabash avenue, Chicago, Ill., has been awarded the contract for the lighting fixtures required for the Hudson Building, 32 Broadway, Manhattan Borough.

THE BEST METHOD OF SETTLING DAMAGE CASES AND THE PREVENTION OF ACCIDENTS BY THE USE OF FENDERS OR OTHERWISE.

(Continued from page 14.)

3. Carefully drawn, explicit rules for operating cars made with due regard to the various local conditions should be rigidly enforced and intelligently observed.

4. Speed on various lines should be regulated according to the chances of accident presented.

5. Every car should be equipped with the best controlling apparatus, gong and headlight, and also be provided with such devices for the prevention of accidents as may seem practical.

By this last statement several good devices for the prevention of accidents are rather indefinitely referred to, among which the fender and the safety gate should be placed at the head. Experience has shown that the fender is seldom a nuisance and is frequently of great value. A simple type will be found to be very practical which, while it does not insure against injury, yet very often prevents serious results. The dropping or lowering of the fender is seldom of any benefit, as motormen are generally too much occupied in stopping their cars when a collision is imminent to pay attention to the fender. In many cases where the speed of cars has been reduced from a fast to a slow rate the fender will pick up with no harm resulting persons who without it would surely go under the car. Where the collision occurs while the car is under great speed, serious injury is not unlikely, but even in these cases loss of life and limb may frequently be prevented and money saved in the long run.

The safety gate, with which all motor cars in Minneapolis and St. Paul are equipped and which was not generally approved upon its introduction but a few seasons ago, has demonstrated its great value and practicability by almost annihilating those accidents which occur through boarding or alighting from cars. The danger of these accidents increases with the number of passengers carried and on nearly every road they cause a large part of the injury and damage expense. They present to the fakir the best opportunity for making a case, and always give the jury a good chance to give the plaintiff the benefit of a doubt. The safety gate is practical for any city. In fact, we have seen its best use when our road was earning over three times its ordinary receipts. With it the conductor has but one part of his car to watch while giving the starting bell, and in case there is reason for passing persons at crossings, there is no danger from their trying to board the moving car. It also affords protection to people standing on the rear platform in case of a car rounding a curve at high speed, or on other occasions, when a passenger through his own condition or carelessness, or the operation of the car, is liable to fall off.

As the gate is operated by the motorman it should never be opened until the car is at a standstill, and should always be closed just before the power is applied for starting. After the public becomes accustomed to the safety gate, its operation demands no change of running time from that used before its introduction. The most timid, whether old or young, will walk without fear to the gate while the car is stopping, and thus take but little time to alight. The gate is also of great service in handling large crowds at the parks where people seem to lose their common sense, as well as all ideas of propriety, and try to board and hang on to cars regardless of the danger involved. In such instances the value of but one entrance to the car is quite obvious, as at any moment the crowd may be checked by the closing of the gate and the car started.

The value of both fender and safety gate can best be

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understood by closely watching their use. Both are eminently useful and practical. Both have also a good moral and instructive influence; they caution both the public and the trainmen against accident, and also cause the community to realize that a soulless corporation has some regard for the life and property and sincerely desires to avert accident to them. They also give to the trainmen an assurance in operating the cars, which is of itself of considerable benefit.

Screens for the side of cars (when the trolley posts are between the trucks), sand boxes always filled with sand, and many other devices are also of considerable importance, and tend, each in its way, to reduce the number of accidents to the minimum. It is not possible, however, to operate cars entirely without accidents, and in studying the problem we should not look for perfect results.

The above presents roughly a few ideas suggested by long experience after trying nearly all the remedies known, and gives one the firm opinion that it is essential, so far as possible, to have the best equipment, including practical safety devices and the best men obtainable for operating the cars and for the claim and other departments, governed and aided by the best rules and supported by the best policy.

Wesson, Miss.—R. S. Purser has been awarded contract for electric light plant.

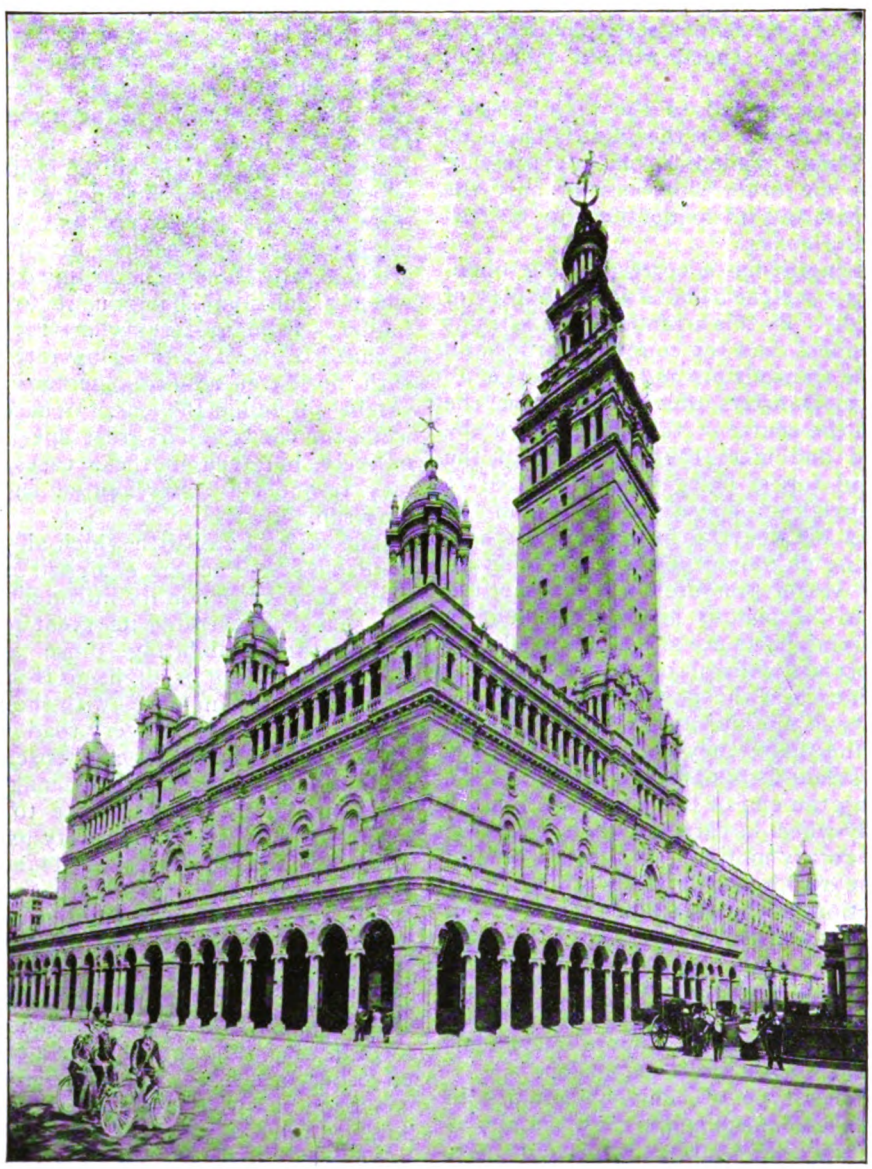
ELECTRICAL SHOW.

Interest in the next Electrical Show to be held in Madison Square Garden in May has already gone beyond the electrical into the kindred trades, and is surprisingly strong in oll branches of the railway business. Everybody remembers the splendid success of the show in 1896.

The exhibitors themselves were paid many times over in business for the cost of their respective exhibits, and the best evidence of this fact is in the early demand from former exhibitors for increased allotments of space. Contracts are already in for more than one-half of the total space sold in 1896.

Railway apparatus and supplies people will get their first real good chance in 1898 show to demonstrate what is being done in those lines. The changes in motive power now being made by street railways in and around the city, and interest taken in electric traction by short steam roads will have a double effect; they suggest to the trade that the active demand for apparatus and supplies will bring to the show great numbers of buyers. The second effect will be a stimulating of public interest in the new modes of generating and applying power to street railways.

From interest already taken in it by the trade, it is evident that the illustration of the various apparatus and supplies will be complete, varied and interesting, and public interest in those things will no doubt lead the



Madison Square Garden, Electrical Show, May, 1898.

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THE RAPID SPREAD OF ALTERNATING-CURRENT MACHINERY.

It is not so very many years since the use of electricity was limited to a few progressive and somewhat ambitious centres of civilization. It was regarded as a luxury of a doubtful nature, and its vast application and huge possibilities remained hidden until the inherent force of spontaneous development gradually unfolded its brilliant future. Since Jablochkoff lit Paris with his electric candle, fed by an alternating current, many widely separated attempts were made to give prominence, not only to this method of lighting, but to the machinery and system from which its power was derived. Those that have seen the twin growth of the two great and parallel systems of lighting and power distribution quickly realize that one would soon outstrip the other in the fight for precedence. But, although a temporary victory lay in the hands of those that had invested their capital and time in the interests of continuous-current machinery, it was soon evident that great attention was being given and earnest efforts made, to solve the new problem—the distribution of power by alternating current. The peculiarly flexible nature of an alternating-current system has appealed to the engineering instincts of many capable men, but the lack of means to properly develop mechanical energy at the end of a power circuit without the use of auxiliary appliances, set back the period of development a great many years.

Nikola Tesla in America, and Dobrowolsky in Europe produced their systems of two and three phase distribution, which in combination with the polyphase motor soon gave rise to a new spirit of enterprise and quickly brought the alternating current forward as an equally able and valuable means of distributing light and power.

The simplicity and ease with which the pressure is raised or lowered, the lack of complication and absence of a commutator in the alternator and the cheapness of construction of the alternating current motor undoubtedly proclaim the alternating current system one of enduring qualities.

The rapid spread of alternating current machinery has become very apparent in the closing years of this century. It leads us to anticipate a time when the application of alternating current will be made by traction companies for city and surburban use. Every available source of water power will perform its real function of sending some of its leaping force into the distant home, serving there as a willing servant, though unrestrained and free in the country hills. Some of the greatest of western mines owe their prosperity to the conjoint application of water power and the alternating current. A mine only becomes productive and valuable when labor is spent upon it, but when a fund of energy awaits the touch of a skilful hand and may be guided through a sinuous line to some adjacent mine, then the earth gives out its treasures without delay and yields to those that fathered such an enterprise munificent dividends, that pour in with undiminished regularity.

UNDERGROUND ELECTRICAL CONDUCTORS.

The new rules and regulations relating to the installation of wires in buildings or streets may be found in the charter of the City of New York. The statements there refer to the qualifications of an inspector of electric wiring, the removal of electric wires and underground electrical conductors. For the benefit of our readers we will insert section 582, relating to conductors placed underground: "Whenever the said Board of Public Improvement shall deem it desirable and practical after hearing all parties interested that the electrical conductors in any street, avenue, highway or public place, of the City of New York, lying within the boroughs of Brooklyn, Queens and Richmond, be placed underground, the said commissioner shall notify the owners or operators of the electrical conductors above ground in any such street, avenue, highway or public place that said electrical conductors shall be placed underground within a certain time, to be fixed by the said commissioner, which said time shall be sufficient for the proper construction of underground conduits or other channels in said street, avenue, highway or public place. Whenever any duly organized company, operating or intending to operate electrical conductors in any street, avenue, highway or public place, in that part of the City of New York which lies within the boroughs of Brooklyn, Queens and Richmond, shall desire to place its conductors or any of them underground, it shall be obligatory upon such company to file with the Commissioner of Public Buildings, Lighting and Supplies, a map or maps made to a scale, showing the streets or avenues or other highways or public places which are desired to be used for such purpose and giving the general location, dimension and cost of the underground conduit desired to be constructed. Before any such conduit shall be constructed it shall be necessary to obtain the approval by said commissioner of said plan of construction, so proposed by such company, and said commissioner shall have power to require that the work of removal and of constructing every such system of underground conductors shall be done according to such plan so approved."

The above facts will probably be of direct interest to electric light companies or such corporations as intend to place wires, extending through suburban districts, underground. We will add a short note regarding the duties of the consulting engineer, appointed by the mayor of Greater New York, as found in section 574: "the consulting engineer of lighting and electricity shall, when required by the commissioner of public buildings, lighting and supplies. examine problems arising from the use of gas and electricity and steam, affecting public interests

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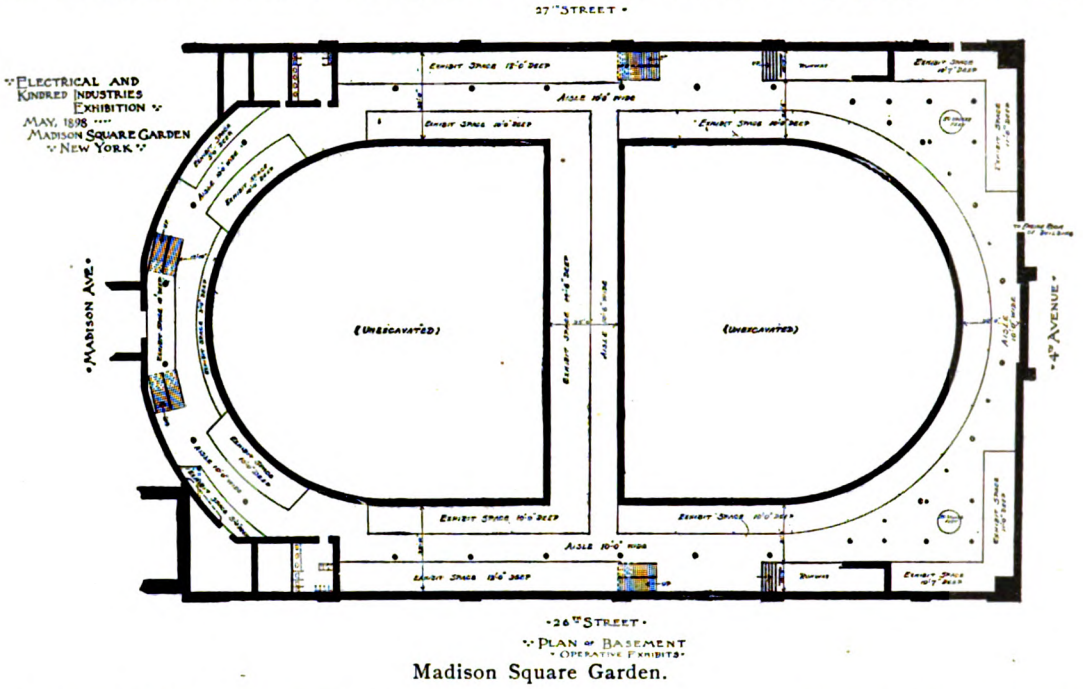
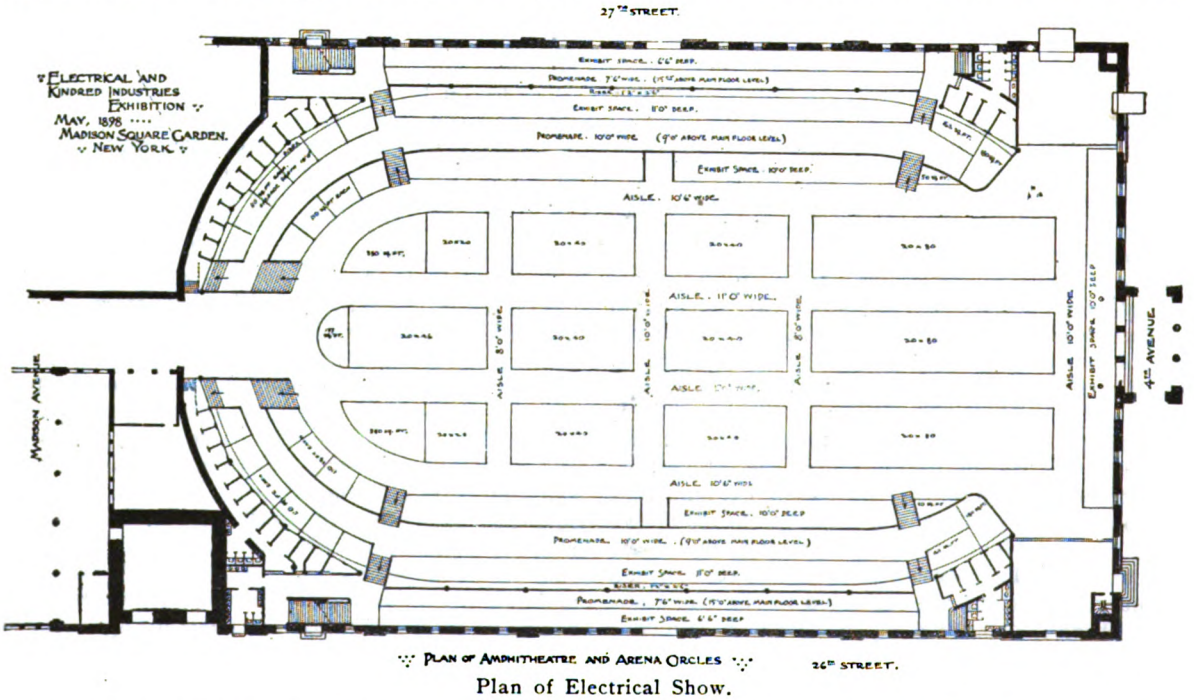
in said city, from time to time, and shall report thereon to the said commissioner from time to time as he may be required. He shall recommend to the said commissioner proposed ordinances for the use and control of gas and electricity and steam, which the said commissioner may submit to the Board of Public Improvement and he shall perform such other duties as the said commissioner may from time to time require."

It may be interesting to some of our readers to become acquainted with the fact that the head of the department of public buildings, lighting and supplies receives a salary of $7,500 a year. He is appointed by the mayor.



Madison Square Garden.



Plan of Electrical Show.

ELECTRICAL SHOW—Cont. from page 20.

newspapers to give this feature of the show a great deal of notice.

The accompanying diagrams show a proposed arrangement of exhibits in the amphitheatre of the Garden where apparatus, supplies, etc, will be located, and the basement in which will be the generating exhibit and steam specialties.

It seems proper to say a word about this generating Exhibit. In the old building, with a smaller and less interesting plant and only one entrance by an obscure stairway from the main hall, it proved to be a feature of public as well as trade interest.

Enough interested people found their way to it to make it profitable to the exhibitors. In Madison Square Garden not only the exhibit will be larger, more varied, more interesting, but it will be more accessilbe. There will be at least four entrances from three sides of the building, and the care and skill in placing the exhibits, pointing out the features and properly advertising them, which made the last operating exhibit successful, ought to make this one at least four or five times as successful.

THE MEASUREMENT OF CURRENT.

LESSON LEAVES FOR THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

The flow of a current of electricity is directly due to the existence of an electric pressure in a wire. Although the evidence of its existence is not such as to give the same

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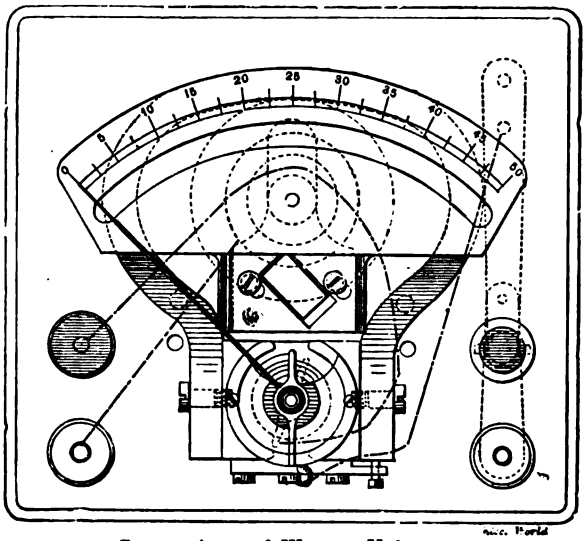
impression as would be received by viewing the steam gauge on a boiler, or the barometer of an air-pump, the reality of its presence soon becomes firmly established in the observant mind.

The forms of apparatus used for the purpose of measuring an electric pressure may be subdivided into three general groups,

Electro-Thermal,
Electro-Static,
Electro-Magnetic.

A spiral spring of high resistance material might be used; when the current had caused it to become perceptibly heated the elongation of the spring would become visible by its tendency to untwist. If one end be rigidly held the other could move a pointer, and thus perform the function required of it—the registration of different pressures.

The great object to be held in view in the construction of voltmeters should be their high resistance. The striking difference always noticeable between current and pressure measuring instruments is the very low resistance of the one and the extremely high resistance of the other.

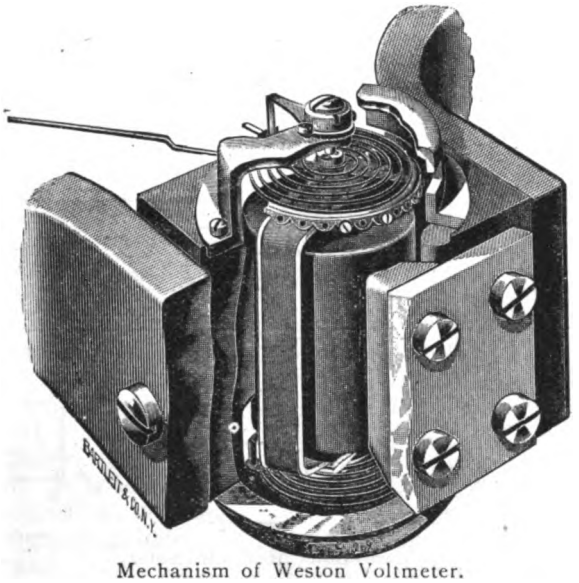


Connections of Weston Voltmeter.

The electro-thermal voltmeter is one in which the expansion and contraction of a metallic body causes a dial or pointer to move by the agency of some intermediate mechanism. The elongation of the wire is caused by the current, which can only increase or decrease when the pressure does likewise. Practically all current carrying voltmeters are of high resistance, and in this case there is no exception.

Electrostatic instruments that measure volts do so without the consumption of any current.

If any electric circuit be broken and the extremities examined, they will be found individually to possess a positive and negative charge. These terms are merely relative expressions for the potentials existing between



Mechanism of Weston Voltmeter.

The best known type of instrument utilizing this principle is the Cardew voltmeter. A long wire of high resistance is strung between two pulleys, a pointer placed in front of a graduated dial is attached to one of them; when the wire stretches, due to the influence of the current, the little pulley over which the wire passes rotates and assumes different positions dependent upon the extent to which the wire has expanded.

By sending in known currents of increasing strength the positions of the pointer may be permanently marked for future measurements; the voltmeter is then said to be calibrated.

two points. An electrostatic instrument therefore simply indicates this condition and measures the difference of potential.

The electrometer which serves the above purpose acts upon a very simple principle. If two oval-shaped pieces of metal be placed at right angles to each other, one insulated and tightly held and the other suspended above the first by a silken thread, the following will occur:

By charging one positively and the other negatively, the upper one will be attracted out of its position and try to assume a new one directly above the stationary plate. The greater the charge on each, the greater the attrac-

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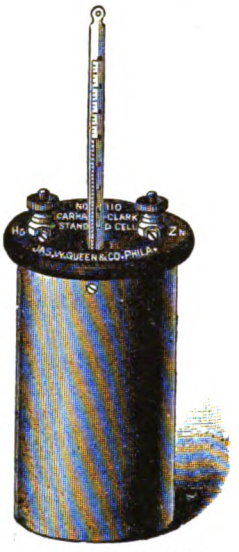
tion exerted between them. By attaching a light pointer to the movable plate, or a mirror throwing a beam of light on a scale, the deflection can be accurately observed.

The laboratory instrument is the quadrant electrometer, while that employed for practical pressure measurements is the electrostatic voltmeter. As both depend upon the same principle, the only difference lies in their respective delicacy of construction.

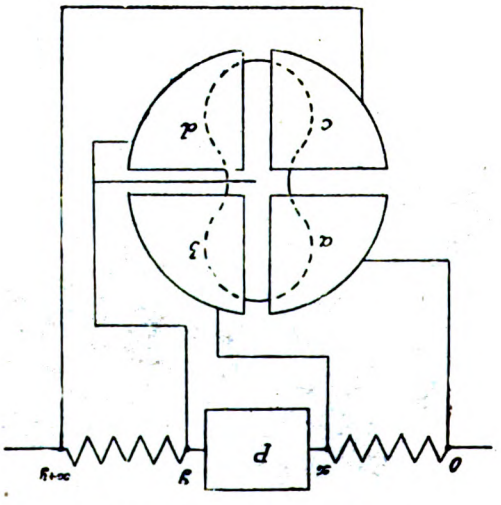
The quadrant electrometer consists of four quadrants lying in one plane and insulated from each other by supports of glass. A metal needle shaped like two opposite blades of a four-bladed fan is suspended above by a fine fibre. A mirror attached to the thread and a scale in front for observing the deflection complete the outfit. Two opposite quadrants and the needle are charged positively and the other two quadrants negatively from the circuit whose pressure is to be measured.

The electrometer was reduced to two long-shaped plates placed vertically, and between them on two light pivots swings the needle with a pointer attached. A small weight holds the needle at zero when readings are about to be taken, but do not prevent the two fixed plates from attracting it out of a perpendicular position where both they and it are oppositely charged. The weight can be changed, and thus increase or decrease the range of the instrument—a heavier weight requiring more difference of potential to move it than a light one. Thus the same scale can be used for hundreds or thousands of volts. The two fixed plates, though in a vertical plane, are inclined in position, the needle being held perpendicularly between them until acted upon by the electrostatic attraction of the two parallel plates.

A quadrant electrometer can measure a very small difference of potential, a fraction of a volt from $\frac{1}{10}$ to $\frac{1}{50}$ being accurately determined.



Standard Cell.



Connections of Electrometer.

The result is:

Volts = constant × square root of deflection.

The constant can be found very easily by applying a known number of volts and noting the deflection, because

$$\text{constant} = \frac{\text{volts}}{\text{square root of deflection,}}$$

thus giving it for future use.

The development of the electrometer into a direct reading voltmeter was effected by Lord Kelvin in an interesting manner.

An electrostatic voltmeter is used for very great pressures, their range including five or six thousand volts. An electrometer possesses the great advantage of being able to measure the pressure of an alternating current, although, to do so, the ordinary connections must be somewhat changed.

The electrostatic voltmeter can be immediately used for this purpose without change, as the reversals of potential do not destroy the attraction existing between plates and needle, whether the needle be positive and the two plates negative, or the needle negative and the two plates positive.

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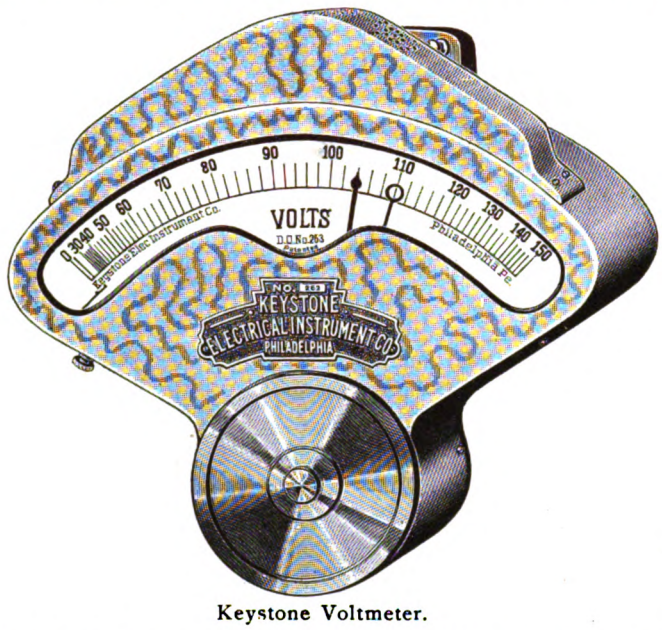
Electro-Magnetic.—A difference of potential can be measured by the electro-magnetic effects produced in a coil of wire, provided the general adjustment of parts be such as to enable the changes that occur to become evident. Those of the last named type have made use of the electrostatic force and do not depend upon a flow of electricity to produce readable effects; in this respect there exists an essential difference between them.

The simplest form of instrument by which an electric pressure can be measured consists of a coil of wire that attracts a soft iron core. The resistance of the coil is very high, being made of fine wire, and an additional resistance sometimes added in the form of a reel of german silver brings the resistance up to a very high point. A dial placed in front of an arm actuated by the moving



Keystone Voltmeter.

core can be easily calibrated by the application of a series of known pressures, each being individually marked on the dial as the needle or pointer shifts, due to their influence.

A galvanometer can be used for the purpose of measuring great differences of potential by utilizing a shunt in connection with it.

Great use of the standard cell has been made in test work of the finest kind. This is simply a very well made primary cell of constant E. M. F. at a certain temperature. The two generally known in laboratory practice are the Clark and Carhart cell. The deflection obtained on a galvanometer with one of these and a fixed resistance and shunt can, by comparison, be made the basis for further calculations with greater pressures under the same conditions.

Weston Voltmeter.—A voltmeter of well-known make is that invented by Edward Weston. It is built upon the principle of the D'Arsonval galvanometer, and for accuracy and reliability stands unequalled. It is inherently a galvanometer, but of so practical a construction that in spite of its delicacy it can suffer rough usage before becoming injured to a perceptible degree.

It is to be remembered that the ordinary type of galvanometer consists of a fixed coil and a movable magnetized needle. In the above instrument, however, these conditions are reversed. Instead of a small magnetic needle subject to the influence of a thousand disturbances, there is a heavy steel horseshoe magnet whose extremities are hollowed out to receive a small coil of fine wire mounted on pivots. Two watch springs convey the current to the coil, one being connected to each end of it, though insulated from each other. The current after traversing this coil passes through a series of finely-wound reels of german silver wire of exceedingly high resistance.

The metallic drum around which the coil rotates prevents any unsettled swing, thus rendering it dead beat. The magnet is rigid in this instrument, and the coil swings freely in contradistinction to the last and more familiar style of ordinary galvanometer.

A pressure can be measured by a system of comparison, as follows: A known high resistance is connected between two points, the difference of potential between which is to be measured. A standard cell and galvanometer are then connected to it so that their respective currents tend to flow in opposition. When a point in the high resistance is reached at which no deflection takes place, the pressure from the cell and the difference of potential between the extremities of that portion of the high resistance balance. Supposing the standard cell to be two volts and the resistance creating this equilibrium between its ends twenty ohms, there will then be as many times two volts in the wire as twenty ohms are contained in its entire resistance. Were the entire resistance of the wire one thousand ohms, the difference of potential existing between its ends would be one hundred volts.

Drop of potential is ascertained in a very simple manner worthy of notice.

When a known current is passed through a wire of known resistance, the fall of pressure throughout the wire can be at once calculated by the rule:

Drop of potential = current × resistance. The pressure at one end of the wire will vary from that of the other end by that difference. In order to make this method of avail an ammeter must be used and the resistance of the wire carefully determined.

In shop practice, where an ammeter is the only accessible instrument, a definite number of feet of copper wire will use up a pressure that is not great. The resistance of the wire per thousand feet is given in catalogues of wire manufacturers. The current passing through it will complete the data necessary, and the calculation can be made

with 1,000 feet No. 10 wire = 1 ohm,
with 30 amperes flowing.
Drop of potential = 1 × 30
= 30 volts.

Many interesting problems arise from a study of the drop of potential in a wire. The system of subway distribution, the network of circuits to be supplied to a house, are all built upon the basis of a certain estimated drop from point to point. And the illumination within depends entirely upon the care with which such considerations are made.

Thus the methods above outlined contains the essen-

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tial principles depended upon for any reliable result in the measurement of pressure.

Electromotive force and difference of potential differ in this respect from each other. The inherent cause of electrical phenomena is due to the presence of a current or charge, but an electromotive force has given rise to the current by establishing a difference of potential between two points, thus allowing a flow of electricity to occur when the circuit is completed. In a cell of battery there are electromotive forces at work within the cell creating a difference of potential outside, by whose means a current can flow if permitted.

Thus electromotive force may be looked upon as the prime cause from which follow the subsequent effects of difference of potential and a current of electricity.

The volt is a unit of pressure. It will send a current of one ampere through a resistance of one ohm.

It is defined in other ways by reference to a magnetic system. The unit of electromotive force is that which is created in a conductor moving through a magnetic field at such a rate as to cut one unit line per second.

This definition has practically been adopted by all as the basis of the volt. The volt, such as considered in practice as a unit, would be equal to that electromotive force generated within a conductor cutting 100,000,000 lines of force per second.

Some molecular action within a wire sets up a disturbance whose effects are heat, magnetism and electricity; when the agitation becomes extreme, the heat accumulates with too great a rapidity for instant radiation and the phenomenon of light appears in all its gradations. The original cause of such effects is an electromotive force free to display its activity in so striking a manner.

QUESTIONS FOR REVIEW.

(1) The measurement of pressure is possible by what form of apparatus?

(2) Describe the electro-thermal voltmeter?

(3) Explain the action of the electro-static voltmeter?

(4) What is a quadrant electrometer?

(5) Upon what principle does the Weston voltmeter operate?

(6) (a) What is meant by drop of potential?
(b) What is a volt?

E. P. MORRIS, the manufacturers' agent of electric light and railway supplies, 15 Cortlandt street, New York, is the selling agent for the Keystone Electrical Instrument used in the reading columns of the January 8 number.

MR. SEYMOUR, of PASS & SEYMOUR, manufacturers of porcelain, incandescent electric-light fittings, switches, cut-outs, etc., was in town this week at Mr. F. M. Hawkins' office, 39 Cortland street, their Eastern agent. Mr. Seymour is exhibiting a new porcelain socket made specially for Edison base lamps. The lamp can be inserted the same as in a Westinghouse or T. H. base and can be unscrewed or screwed in the same as an Edison socket, only the metal part is slotted as in the above sockets. The bottom of the socket contains a spiral spring, so that in case the lamp should loosen, as it sometimes does in an Edison socket, you will always have current and light.

THE HAZELTON BOILER COMPANY, 716 East 13th street, New York City, call their new catalogue "The Generation of Power," and justify the title by giving, in addition to the description of the boiler, a number of useful tables and articles on the combustion of coal, generation of steam, feed pipes, etc. The boiler and its features are clearly described and illustrated.

Many improvements have been made in this boiler, which not only increase its efficiency but also improve its appearance. The tubular matter in this book has been well selected and carefully edited, and is taken largely from the works of well-known authorities on this subject. It will be sent on request.

MESSRS. FOSTER & LOUIS, contractors, Fisher Building, Chicago, have sold their contract for the building of the Holland, Mich., electric railway and lighting plant to Messrs. H. B. Black, I. E. Cockran, Jr. and Mr. Powell, all Chester, Pa., capitalists. At a recent meeting in Chicago of the Holland & Lake Michigan Railway Company, Messrs. Humphrey, Larsons and Ferguson were succeeded by the election of new officers, as follows: Mr. H. B. Black, president; Mr. Powell, treasurer; I. E. Cockran, Jr., secretary, at which time the stock and bonds were also turned over to the new organization. The city of Holland has extended the franchise which expired January 1, 1898, to June, 1898. This road when completed will be seven miles in length and will operate between Holland at the head of Black Lake and Ottawa Beach and Mackatawa Park, well known Michigan summer resorts. The grading, bridges and power house are all completed, and the machinery is on the premises. It will take some four or five weeks to complete the road ready for operation.

THREE DIPLOMAS OF MERIT to one concern shows pretty well what the judges of the Tennessee Centennial Exposition (held at Nashville in November), think of the Robertson-Thompson Indicator, Lippincott Planimeter and Eureka Packing. Jas. L. Robertson & Sons, New York, entered these three articles and inform us they were awarded these prizes. They say if engineers and steam users would send for illustration, and descriptions of these goods, it would not only be of interest, but profit.

THE ONE HUNDRED AND EIGHTY-FOURTH MEETING of the New York Electrical Society, will be held at the College of the City of New York, 23d street, and Lexington avenue, on Wednesday, January 12th, at 8 P. M.

Mr. S. Dana Green will read a paper on "The Relations Between the Customer, the Consulting Engineer, and the Electric Manufacturer."

It will be the aim of Mr. Green, in this paper, to assist in bringing about that better understanding between these departments of the industry, on which much of its prosperity and welfare depends.

RUBBER WIRE COMPANIES meet January 6, at 115 Broadway, to determine the value of the propositions made to combine.

THE MANUFACTURERS AND SUPPLY DEALERS in electrical goods generally meet at Astor House to-day to decide upon some plan to make a living rate on all goods sold.

Blacksburg, Va.—S. A. Bross & Co. will install an electric light plant in flour mill now in course of erection.

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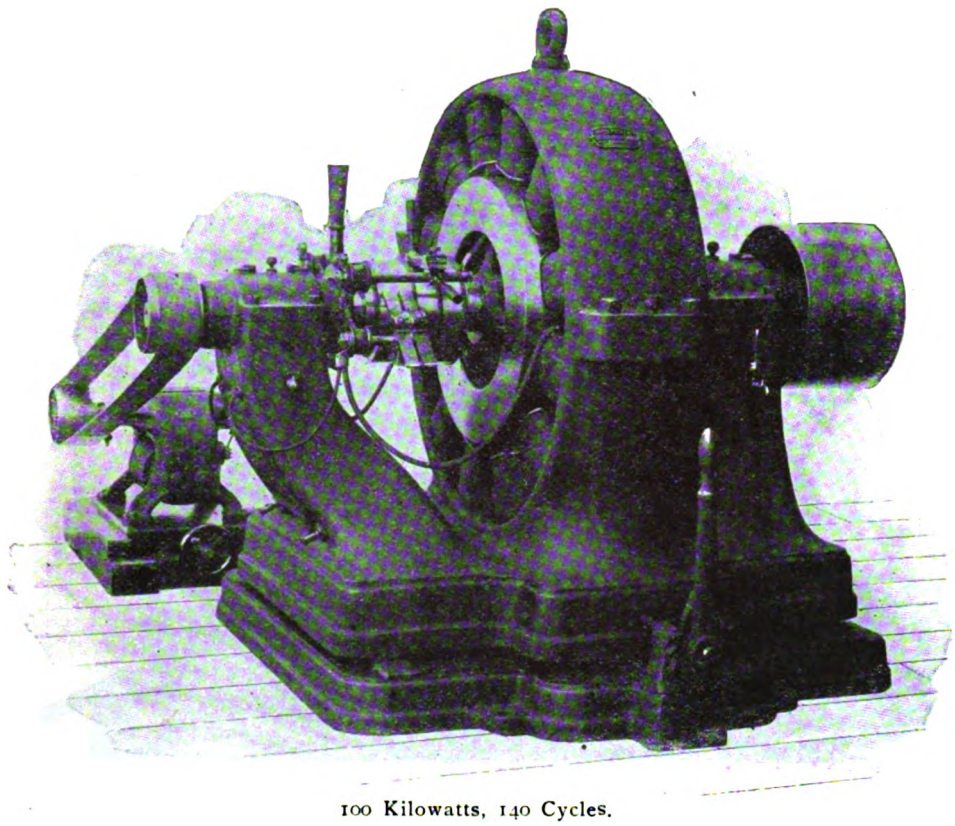
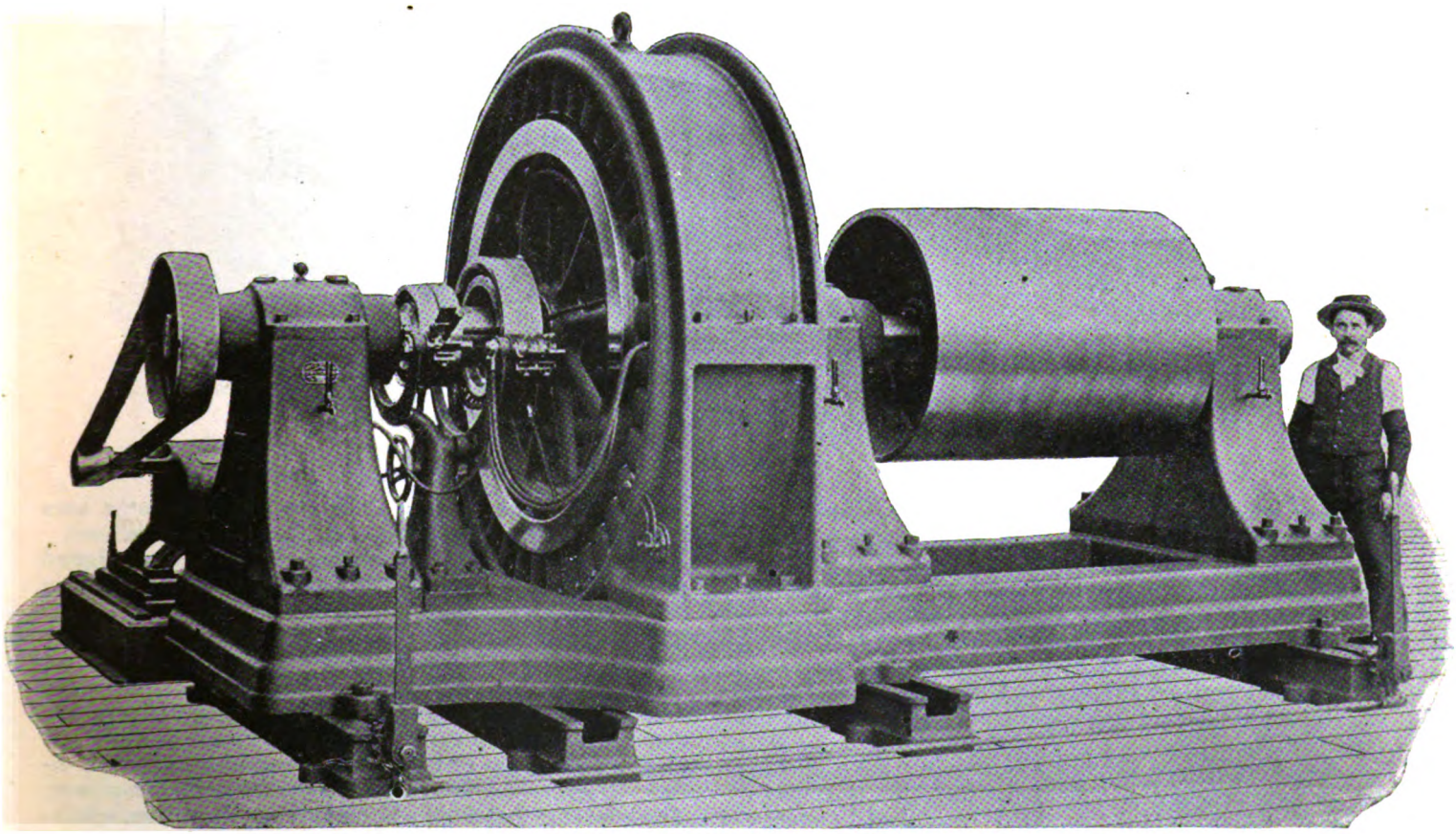
The Electrical Age.

VOL. XXI—NO. 4 NEW YORK, JANUARY 22, 1898 WHOLE NO. 558



100 Kilowatts, 140 Cycles.



400 Kilowatts, 140 Cycles.

UP-TO-DATE ELECTRICAL ENGINEERING.

Many papers have commented on the above subject without fully realizing that they had but to turn their eyes in the proper direction to see what up-to-date electrical engineering really consisted of. The question is not one requiring abstract discussion, because it is fully represented at present in types of apparatus and methods of construction that clearly show what up-to-date electrical engineering has been and is doing. It is truly said

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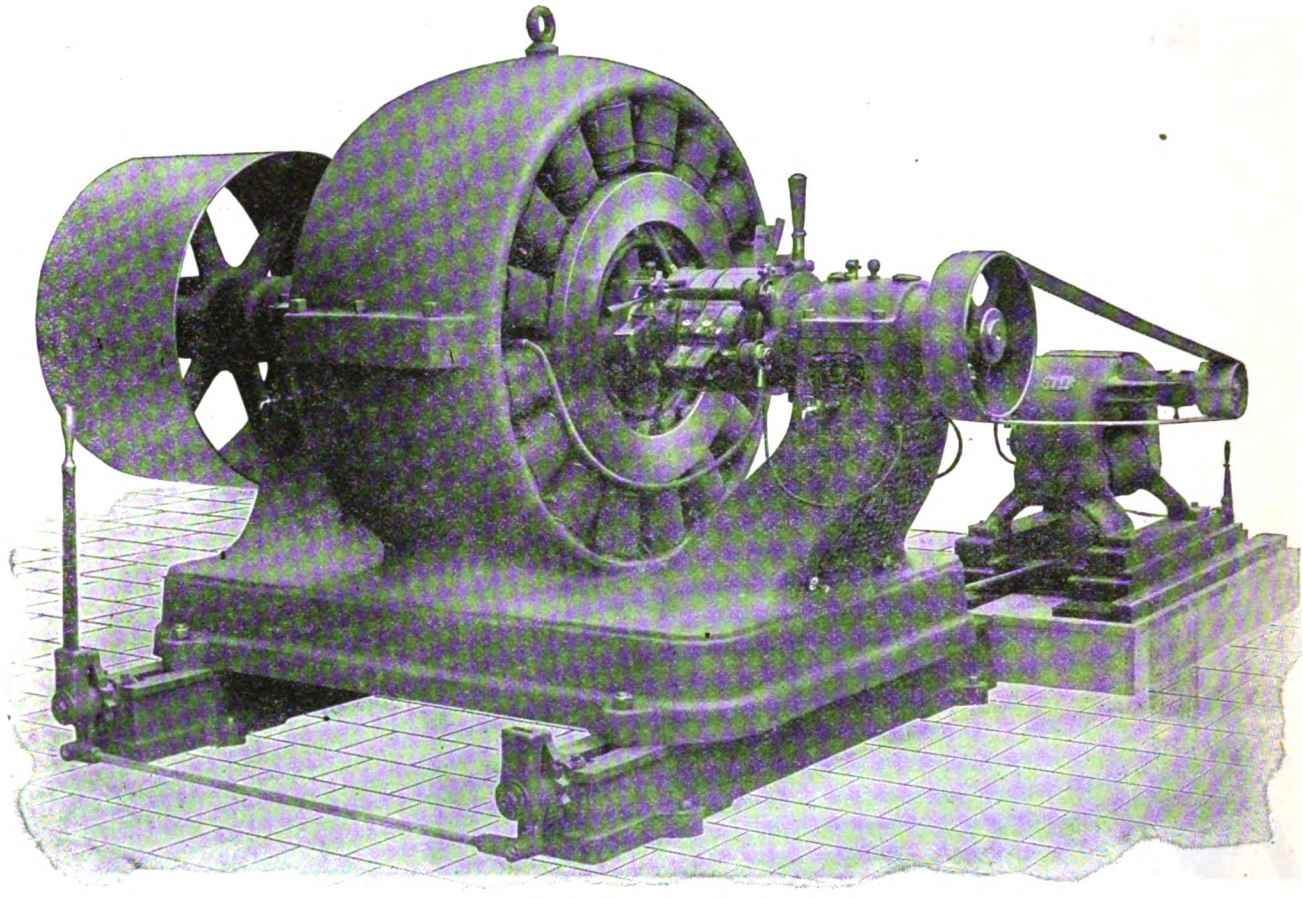
that the man of energy works and says little. Nothing is more true of the manufacturing concern whose object is clearly kept in mind and who, without self-approbation, quietly and deliberately succeeds in accomplishing what others fail in; brings before other manufacturers and a host of increasing customers the labor of their hands, the perfected devices that reason and art have enabled them to construct. People say, alternating-current apparatus has become popular. This is a tardy recognition of the labors of the firm that has made it so. The Fort Wayne Electric Corporation, of Fort Wayne, Ind., have gradually increased the field of their efforts and expanded into a concern whose stability and reputation is the result of years of experience. The "Wood" compound-wound alternators for high and low frequency, manufactured by them, are certainly the leaders of their class. They possess a composite field circuit, with laminated poles cast into the yoke, thus saving a great percentage of the copper formerly used and increasing the output of the alternator to a large degree. In the armature the spiders and clamping rings are so ventilated that the temperature of field coils, pole-pieces and armatures is effectively reduced. The use of an improved commutator, closed at both ends, and thus kept free from deposits of foreign matter, represents a final touch that will favorably impress the electrical engineer. Each part of the machine is tested with eight thousand volts before placing upon the market.

The Fort Wayne Electric Corporation have perfected to a high degree a new line of alternators, specially designed for low frequencies, the advantage and benefits of which are low speed, low temperature and high commercial efficiency. The sixty-cycle machines referred to are wound for 1100 or 2200 volts at full load, respectively. The illustrations included in this article are those of a hundred k.w. and 140 cycle machine; 150 k.w.; 60 cycles, and 400 k.w., 140 cycles. The alternators, as seen, are separately excited, but being compound wound, regulate perfectly for all changes of load. The capacity of any generator may be measured by its power to radiate heat.

It is therefore evident that the wholesome design of these solidly built machines, their power of rapidly dissipating the C^2R loss, perfect magnetic circuit, high permeability, improved commutator construction and general mechanical excellence, will make them capable of withstanding the heaviest strains of service. The 100 k.w. alternator runs at 1,050 revolutions a minute, has 16 poles, is 62 inches high, covering a floor space of 83 in. x 70 in.; its armature weighs 1,350 pounds and the alternator, complete, 7,500 pounds. The 400 k.w. alternator has 36 poles, runs at 467 revolutions per minute, is 98 inches high, occupies a floor space of 185 in. x 96 in., its armature weighs 7,900 pounds, and the alternator, complete, 36,600. The low frequency, 150 k.w. alternator has 16 poles, runs at 450 revolutions per minute, is 69 inches high, occupies a floor space of 115 in. x 77 in., its armature weighs 3,450 pounds, and the alternator, complete, 15,400 pounds. The 400 k.w. alternator uses a pulley 40 inches in diameter with a 50-inch face.



150 Kilowatts, 60 Cycles.

The Fort Wayne Electric Corporation have designed and constructed on the basis of the "Wood" system direct-current dynamos for light and power, for either belting or direct connection. The armature of a 75 k.w. generator is shown, which runs at 275 revolutions. The assembled machine, whose guaranteed output is the same at full load, weighs but 7,825 pounds, delivers 600 amperes, 125 volts pressure, requires 113 horse-power at full load. The weight of this machine averages up for the direct driven type about seventy pounds per horse-power. The efficiency is high, its smoothness of operation, sparklessness at all loads and low speed are among its most valuable features. Its safety factor is so large that its good points would be preserved even with a twenty-five per cent. overload. When sold for direct connection the field crown, armature, front pedestal and the field regulating rheostat only, are furnished. If the generator is to be belt driven, the rear pedestal base and sub-base, as shown, form part of the equipment. These dynamos are

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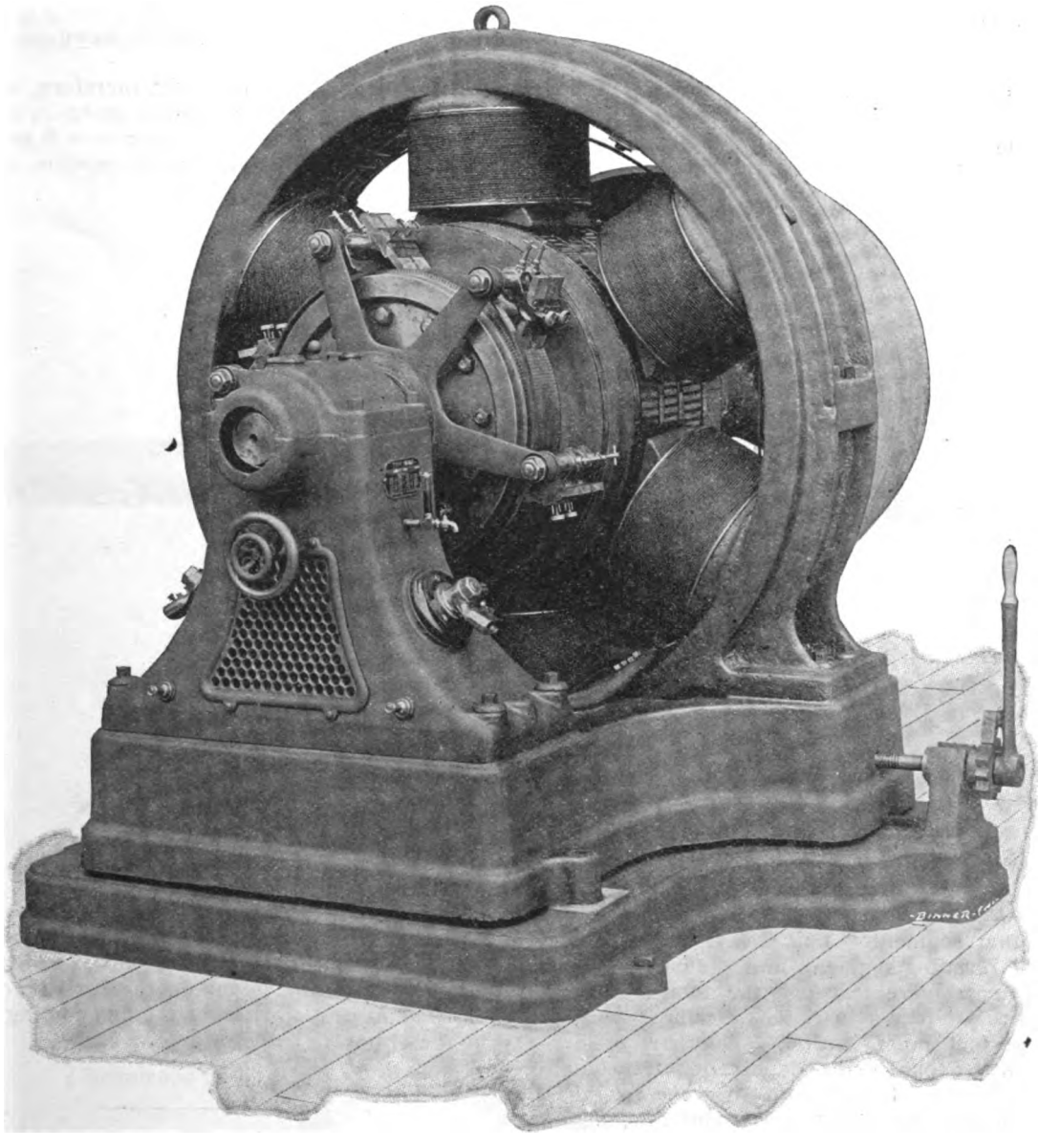
compound wound for 125, 250 or 500 volts, and may be used and will be delivered when so ordered, for direct connection or belt driving.

The above multipolar generators are made with cast steel frames, which is considered the best of practice in modern machinery, its high permeability and the ease with which it is moulded have made it a pronounced success. The designers of Fort Wayne machinery thoroughly understand the meaning of up-to-date electrical engineering as shown by the perfect proportions of their dynamos and the world-wide reputation they have secured.



15 Kilowatts, 275 Revolutions.

SPARKING, ITS CAUSE AND EFFECTS.

(Continued from page 32.)

Following are some of the various ways in which imperfect commutation may occur, and the manner in which this imperfect commutation causes injury to the commutator.

First. Suppose that the current flowing across the contact surface of the receding segment does not decrease as rapidly as the contact surface of that segment decreases. The current density then increases and is a maximum at the last part of the segment that touches the brush. More energy is thus concentrated at that point than at any other, and owing to the fact that time is required to conduct that energy to other parts of the segment, that part will be raised to the highest temperature. This temperature may be high enough to melt, or even volatilize the copper of the segment, therefore when the brush leaves the segment, the current continues to flow through the film of melted copper, volatilizes it and draws an arc. This arc constitutes the injurious or "vicious" spark. The removal of the volatilized copper from the receding edge gradually wears that edge away. Reduction of the contact surface thus continually increases the current density, and the arc is formed at an earlier stage of the commutation when the current to be broken is greater, and thus the spark increases in viciousness until the commutator has to be turned down before the machine will run at all.

Again the energy developed at the receding edge of the segment may not be sufficient to melt the copper. In this case the current to be broken when the segment leaves the brush will jump across from the brush to the segment. This spark has no deleterious effect, since most of its energy is developed in the space between the segment and the receding brush, instead of being concentrated at the edge of the receding segment. This spark is of the same bluish color as that of the Ruhmkorff coil, by which it may be distinguished from the injurious spark, which is yellow.

Second. Suppose that the current flowing across the contact area of the entering segment increases more rap-

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idly than the contact surface increases. The current intensity in that part of the segment then increases, and more energy is concentrated at this point than at other parts of the segment and it will accordingly be raised to a higher temperature. If this temperature is not high enough to melt the copper, no harm results and there is no spark, since the contact is not broken at that point. If, however, the temperature produced is high enough to melt the copper, the melted copper may be carried along by the brush, and the entering edge of the segment is thus gradually eaten away. This will not show by any sparking immediately, but it will eventually cause a spark to appear in the following manner: The eating away of the entering edge of the segment gradually reduces the area of the entering segment, and thus increases the resistance of that segment. This delays the decrease of current in the receding segment, and the current density in both segments increases until the temperature gets high enough to produce a spark as described in the first case of imperfect commutation. Another incidental injury that may occur is the deposition of the melted copper at the back of the segment, thus raising the surface of the segment at that point, and this, together with the depression of the surface at the front of the segment would cause the brush to jump and chatter, which of itself would cause deleterious sparking.

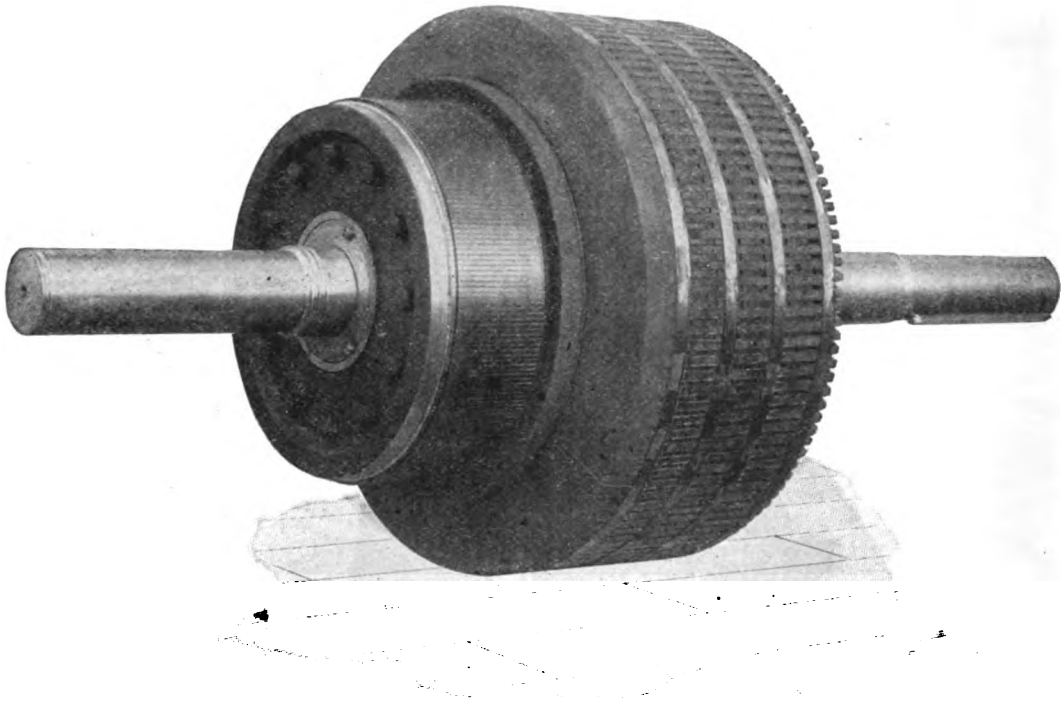
This would explain the cases where a machine runs perfectly sparkless when first set up, but after a time commences to spark, the spark increasing in intensity and deleterious effect and disappearing when the commutator surface has been turned up, only to reappear after sufficient time has elapsed. The wearing away of the front edge of the segment is hardly likely to be noticed, since no injury would be looked for until the spark appeared, and then the cutting of the back edge would be much more prominent, because that, being produced by an arc, would have a roughened appearance, while the surface of the front edge wonld be left smooth by the rubbing off of the melted copper.

Third. The reversal E may be large enough not only to reverse the current in the coil under commutation, but even to increase it beyond the value of half the brush current. In this case the extra current would flow through both segment furnaces, but owing to the fact that this current would be increasing while the receding segment was reducing its contact area, that segment would get hottest, and as soon as it reached the melting point an arc would be drawn and destructive sparking would ensue.

The problem that the designer of the modern machine has before him is to design a machine that will run from no load to 25 per cent. above full load without sparking, and without movement of the brushes.

In the case of machines intended for lighting, the conditions of no shifting of the brushes is not generally required, but most of our modern lighting machines are made to fill that requirement.

The current to be reversed, therefore, varies from the exciting current of the machine up to 25 per cent. above its full load current. The inductance E and the CR drop in the coil also vary in this proportion, and for perfect commutation through all these varying loads it would be necessary for the reversal E also to vary in the same proportion, and may even decrease with increase of load, on account of distortion of the flux coming from the field by the armature ampere turns.



Armature 75 Kilowatts, 275 Revs.

(To be continued.)

THE ONE-HUNDRED AND EIGHTY-FOURTH meeting of the New York Electrical Society was held at the College of the City of New York, 23d street and Lexington avenue, on Wednesday, January 12, at 8 p. m. Mr. S. Dana Greene read a paper on "The Relations Between the Customer, the Consulting Engineer, and the Electric Manufacturer."

It was the aim of Mr. Greene, in this paper, to assist in bringing about that better understanding between those departments of the industry on which so much of its welfare and prosperity depends.

GEORGE H. KIMBER, representing Clifton Conduit, made by the Clifton Manufacturing Company, Boston, Mass., the Bibber, White Company, and the Crefeld Electric Works, manufacturers of magnet, office and annunciator insulated wire, has moved to 15 Cortlandt street, New York.

Philadelphia, Pa.—The Collegeville Electric Railway have entered into an agreement with the Reading Railway Co. whereby they will cross the Perkiomen Railroad at grade in Collegeville.

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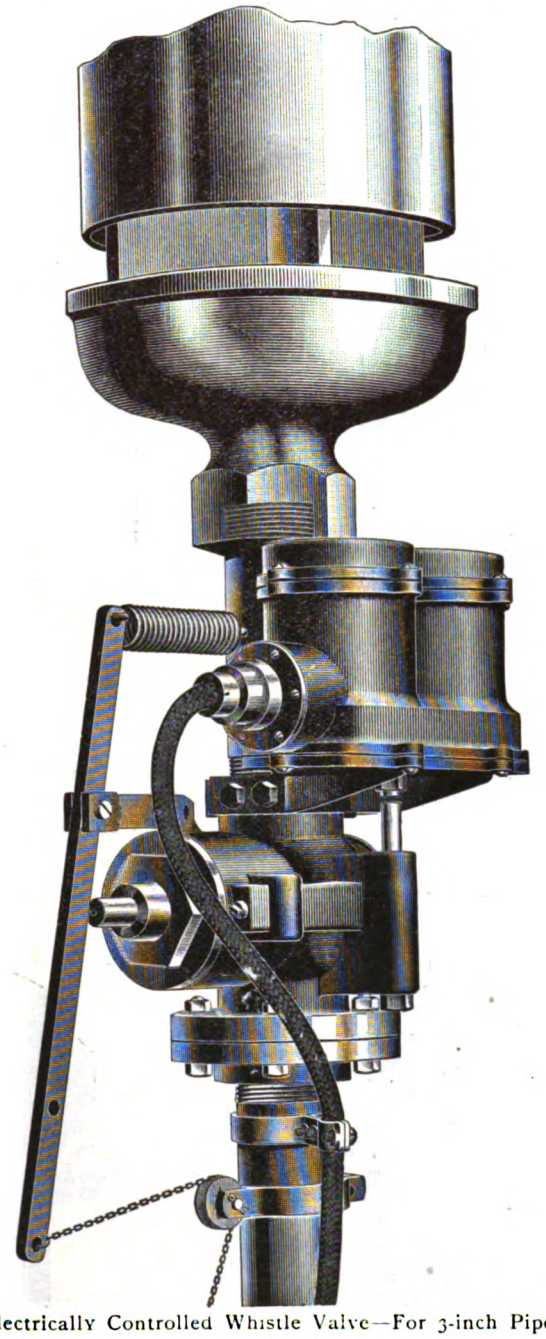
THE ELECTRIC AUTOMATIC WHISTLE OPERATOR.

An interesting and ingenious device is being manufactured and sold by the Signal & Control Company, 45–47 York st., Brooklyn, N. Y. It is a device for electrically controlling a whistle valve, operating it automatically at given periods of time, so that the whistle will signal regularly when vessel is under way, or if at anchor, will ring ship's bell five seconds every minute as required by rules of the road at sea. The electric valve is placed between the hand-pull valve and the whistle. The switch is connected to the valve by means of a weatherproof and certainly waterproof cable. It requires but little current to operate the valve, which may be obtained from a few cells, primary or storage battery, or the dynamo current. The great advantage of the electric automatic whistle operator can be readily understood when the reader realizes that the law requires a series of systematic signals in foggy weather. The automatic valve issues these signals with perfect regularity at given intervals.

There are many occasions when collisions occur and sea accidents of a most horrible nature, entirely due to some fault in signalling, either presumed or having actually occurred. Such questions cannot arise with this device, because its absolute reliability is one of its most pronounced features. The captain may have his mind at rest or occupy himself with other important duties when fog settles upon the ship and the view becomes obstructed. He can still control the whistle-switch and stop the fog signal, at the same time remain in the pilot-house and exercise the fullest control over his vessel. The electric automatic whistle operator is being used by the United States Navy Department for all cruisers, monitors and battleships. The principal steam yachts, Ward Line, Red Cross Line, Boston Fruit Co.



Electrically Controlled Whistle Valve—For 3-inch Pipe.

The Light-House Board and Revenue Cutter Service have adopted it, and the Cunard, American, White Star, North German Lloyd, Hamburg-American, Red Star and Atlantic Transport Lines, the Old Dominion, Providence, and Stonington, Montauk Steamship Company and the Northern Steamship Company use it exclusively. The heads of the merchant marine and the marine departments of the United States have endorsed its use, and all of such experience that their opinion possesses any value will understand and appreciate the great benefits to humanity derived from the use of this important device.

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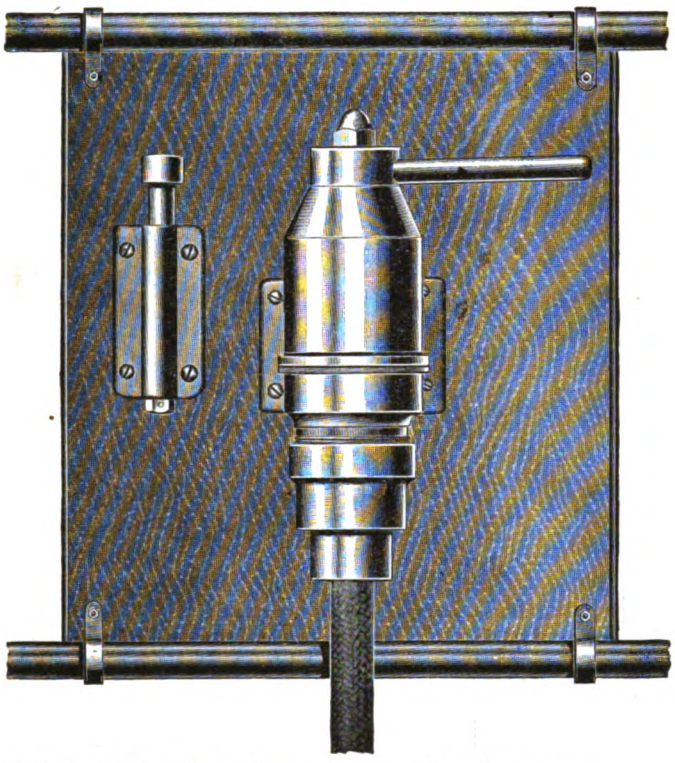
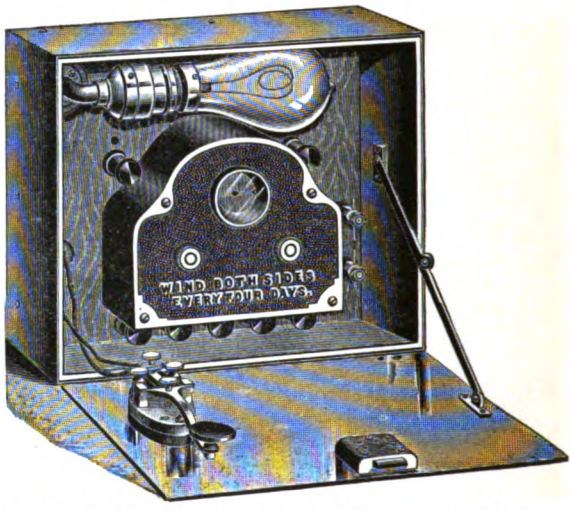
Marine Telegraph System.—Steamships desiring the full and perfect equipment of apparatus of the above nature use, in conjunction with the operator, the marine telegraph system, as manufactured by the Signal & Control Company. The illustrations show a multiple switch with telegraph key, ocean marine multiple switch, and improved United States Navy standard. By means of the multiple switch and telegraph key, the captain can communicate with other vessels by simply following the dots and dashes of the Morse code. It is not a difficult matter to discriminate between the length of a long and short signal, and the captain may easily occupy the position of an operator, provided he follows a card having the Morse code printed upon it. Life saving stations provided with telegraphic instruments of this nature can readily communicate with vessels at sea. As compared with the primitive method of signalling with flags, this scheme takes but one one-hundredth of the time and possesses the additional advantage of being available at night. If the distance is too great between the points of communication, escaping steam, which is visible a distance of many miles, can be used instead. By the use of the whistle telegraph, a message of mercy can go speeding on its way night or day, in calm or in storm.

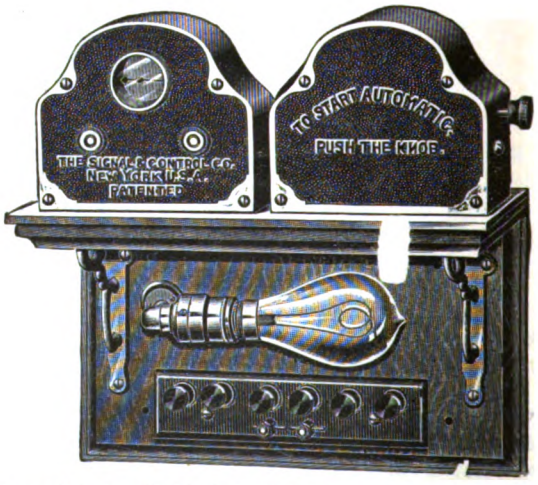


Whistle Switch.—Located convenient to officer in charge, at different points of the bridge, or pilot-house.



Improved U. S. Navy Standard.—Size 9x10x5 inches, when closed.

Multiple Switch, with Telegraph Key.—Size 10x15x5 inches, when closed.



Ocean Marine Multiple Switch.—Size, 13x13x6 inches.

Mr. Hillis, of Bagnall & Hillis, of Yokohama, arrived January 15, and will make his office at 15 Cortlandt st., New York, Room 62.

Cleveland, O.—An electric railroad will probably be constructed from this city to Milford and Terrace Park.

New York, N. Y.—The Manhattan Elevated Railroad Company is about to equip its road with an electric system.

Toronto, Ont.—Ritchie, Ludwig & Ballantyne, solicitors, give notice that application will be made at the next session of the Legislature to incorporate the Toronto and York Radial Railway Company, with the power to purchase the franchise and property of the Metropolitan Street-Railway, Toronto Belt-Line Railway, Toronto-Munico Railway and others.

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THE INEVITABLE OUTLETS OF AMERICAN INDUSTRY.

A book may some day be written entitled "The Rise and Fall of European Manufacturers." It is not with the vain spirit of spread-eagleism that American manufacturers may look forward to the day when many of the industries of Europe will have succumbed to competition and acknowledged by their decease that American manufacturers know how to produce better machinery at a cheaper price than they themselves.

The reports reaching Washington, from the different consuls scattered over Germany, France, England, Italy and Switzerland have indicated the presence of a competing force, perfectly evident in each industrial centre of these countries. The time is not so remote since Americans bought their China plates from Europe and as to any manufactured article in the line of simple machinery, the early Americans acknowledged without hesitation that they were unable to even contemplate other than the crudest methods of manufacture. But since this comparatively short span has passed, since America has grown from the Atlantic to the Pacific and made use of her own natural resources, her ability to produce and manufacture has been so greatly augmented that now, in the face of some of the greatest and most firmly established European manufacturers, she has presumed to set her goods in competition and has found, in spite of ancient prejudices and time-worn notions, a ready sale for them.

The great steel works of the United States are not only supplying the people of this country, but sending tons of this most precious metal to various European and particularly English ports.

One of the proofs that American ingenuity is more awake and comes more quickly to a focus than the same genius in Europeans is found in the rapid sale of American bicycles all over Europe, and the only hope of those engaged in that industry is to compete with the influx of American wheels by the use of American machines and American methods. Bridge building has become a matter of international competition, with the result that Americans have successfully competed with European engineers in this field and secured large and paying contracts. The elevator equipment of the underground road in London was secured by a well-known American firm of electrical engineers and manufacturers. Electric cars completely equipped are being exported from American to English shores and in Germany motors and generators and sundry supplies have found a quick sale and a ready market.

It is evident that the tide is changing and that, unless tariffs are raised for the protection of each mother country, the time is not far off when Americans will transport their goods across the water as systematically and in as large quantities as our European friends formerly did to our own shores.

The problem presented to the student of industrial conditions is a strange one. Why can American manufacturers compete so ably with Europeans when their wage rate is higher? A clew as to the real reason may possibly be found in the absolute system prevailing in all methods employed by the American manufacturer.

Whether this be so or not we leave to others to decide, but the fact is still clearly evident that the drift of manufactured products and particularly the sale of American-made machinery is to be found annually increasing in lands as well equipped as our own for the same work.

THE IMPROVEMENT OF CANALS.

The organization founded for the improvement of canals in this state has as its president George Clinton, of Buffalo, whose grandfather was the founder of the Erie Canal. The organization over which he presided was known as the Union for the Improvement of the Canals of the State of New York. Their work in connection with the improvement of the Erie Canal was of considerable importance, and the influence they exercised is felt today stronger than ever. In 1894, on the Seymour plan, it was proposed to spend $12,000,000 on canal improvement. Unfortunately the legislature of 1894 vetoed the scheme. The Executive Canal Committee was formed in the same year with Chairman Balch as its representative, and a measure was brought forward with the same purpose in view. As far as these bills, propositions and schemes are concerned we have but this to say, the legislature does not seem to thoroughly appreciate the value of improvement in the nature of quicker transportation along the route of a canal. The state has been completely deaf to all that refers to the use of an electric system of propelling canal boats. If improvements are to be made, let them be of a radical nature, not merely with reference to the width of a canal or the depth of its locks, but having some bearing upon the question of speed and improved facilities for transporting freight or merchandise quickly from point to point. Let the canals be regarded not only as an outlet of some importance, but as an artery of trade of the greatest importance from which the state could reap an enormous revenue by providing for its people a new and effective means of transportation. We have the canals; what we need now is an electric traction system running along its banks. Let the mule assist ancient civilization, not the new. Let its backwardness make way for the forwardness and promise of the swiftly travelling current.

Newberry, N. C.—The construction of a telephone system is contemplated.

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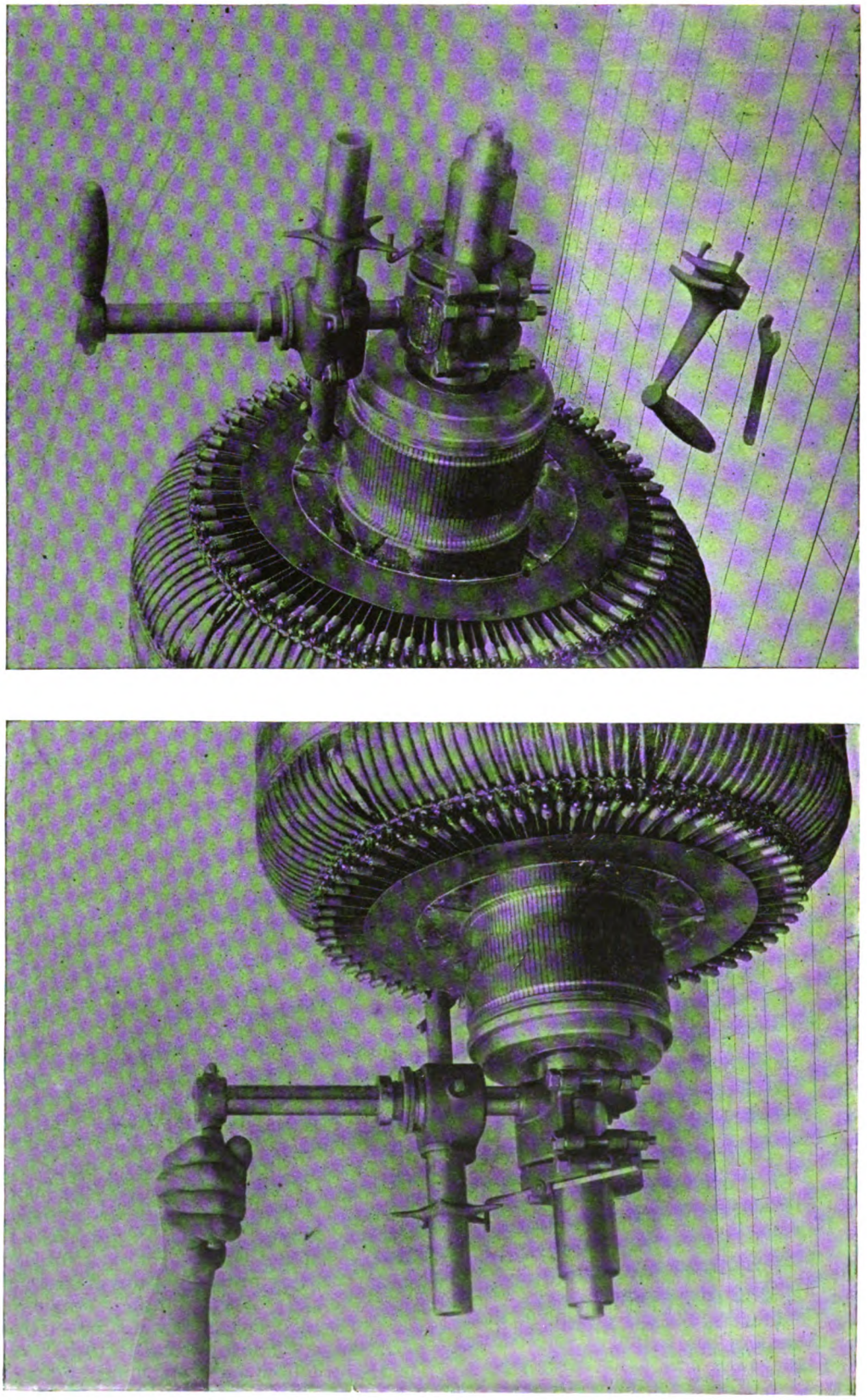
COMMUTER TRUING DEVICE.

One of the most valuable parts of a dynamo is the commutator. It requires great skill and perfect machinery to make a good commutator and it has always been a matter of trouble and expense to repair it when out of order. It sometimes becomes ridged with grooves or develops lumpy segments. When in this condition, it must be trued or turned down. The B. & B. Commutator Truing Device of the Fort Wayne Electric Corporation, Fort Wayne, Ind., is the invention of one of their foremen and assistant superintendents. As will be seen from the illustration, it is intended for connection by a clamp to the armature shaft, around which it is revolved by hand power.

The tool is fed automatically forward with each rotation of the device around the shaft, facing the commutator perfectly true with the bearings. The crank shown in the figure is intended for use when it is desirable to true off the commutator without removing the armature from the machine. The crank is then attached to the pulley and the armature and commutator rotated instead of the tool.

This apparatus was especially designed to meet the re-



Commutator Truing Device.—Patent Applied for.

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quirements of the Fort Wayne dynamos, but is also applicable to any dynamo having commutators within the capacity of the device. It is especially adaptable to the truing off of railway motor commutators and does this work much better than is possible in a lathe, as it leaves the commutator surface perfectly true with the bearings, a very important consideration when carbon brushes are used.

The machine is neatly designed and substantially built and is practically inexpensive when its advantages are considered. In fact, no power or lighting station should be without one, as it saves not only the expense of a lathe but also the expense of cartage to the nearest repair shop.

The engineer will frequently argue against the use of a practical device by claiming that the dynamo under his care never sparks. The possession of a commutator truing device is certainly a ready means of obviating the difficulty as soon as it presents itself. It has been endorsed by the best men in the country, and on account of its ready adjustment and independent action is certainly the best device of its kind on the market.

MEETING OF THE NEW YORK ELECTRICAL SOCIETY.

On January 12th, the New York Electrical Society had its 184th meeting at the College of the City of New York, where most of its this season's meetings will be held.

Mr. S. Dana Greene read a valuable and interesting paper on: "The Relations Between the Customer, the Consulting Engineer, and the Electric Manufacturer."

The aim of Mr. Greene, of this paper, was to assist in bringing about that better understanding between those departments of the industry on which so much of its welfare and prosperity depends.

Messrs. Max. Osterberg, Gano S. Dunn, C. O. Mailloux, H. B. Coho, and Drs. C. E. Emery and F. B. Crocker, took part in the discussion. The following resolution was duly presented and adopted:

Standardization.

Resolved, That in view of the excellent suggestions and recommendations on standardizing apparatus embodied in Mr. S. Dana Greene's paper, the society hereby expresses its approval of efforts in that direction, and invites the American Institute of Electrical Engineers to consider some comprehensive plan for such standardization of American apparatus for electric light and power.

The members elected were:

Otto Rothenstein, Otto Electric Co., Times Building, New York City.

F. K. Vreeland, 228 Orange Road, Montclair, N. J.

F. V. Henshaw, 79 State street, Brooklyn, N. Y.

S. L. Griswold Knox, Crocker-Wheeler Electric Co., Ampere, Newark, N. J.

John Neilson, Supt., Larchmont Electric Co., Larchmont, N. Y.

Putnam A. Bates, 113 W. 72nd street, New York City.

E. B. Higgins, 26 Cortlandt street, New York City.

Thomas A. Edison, 96 Broadway, New York City.

At the request of the president the secretary read the following announcement:

Announcement of Agreement Between the New York Electrical Society and the Electrical Exhibition.

For some time past the New York Electrical Society has been considering means for enlarging its scope of usefulness, and addressing a larger clientage among the citizens of New York, so as to bring the public into more intimate relations with the scientific aspect of all classes of electrical work. The proposition to hold an Electrical Exhibition at Madison Square Garden, next May, appeared to the society to afford it the needed opportunity for putting itself prominently before the public as the oldest electrical body in the country, and the recognized local society, aiming by papers and discussions to diffuse the best electrical information.

The electrical exhibition has very promptly and generously met the views of the New York Electrical society, and has not only apportioned it space in the exhibition hall, for a booth and rendezvous for its members and friends, but has also placed at its disposal a contribution of funds for its educational work. This amount will be increased by a percentage of the admission receipts of the exhibition, which is to be held "under the auspices of the New York Electrical Society." Members of the society will be admitted to the exhibition at half price.

It is believed, from what is already known, that this exhibition will surpass anything of the kind ever done in this city, and will, during the continuance of a month, not only do much to promote electric interest, but enable the society to reach a great many thousand people who should know of its work, and many hundreds who would unquestionably be in its membership.

The Electrical Society is now organizing committees and laying plans for a hearty and active co-operation in the work of the Exhibition and looking, of course, to its own increase of membership and its fuller recognition as an authoritative, influential body.

It is hoped and expected that this will mark the beginning of one of the most successful moves ever undertaken by the Society, and approving comments of friends and members encourage the executive committee to believe that they will be enthusiastically supported in the programme, the sole object of which is to increase and extend the Society's usefulness. The officers would therefore not only urge the members of the Society, individually and collectively, to assist in making the Exhibition as brilliant a success as possible, for the direct benefit that such success will confer on the Society, but also wish to impress on members the desirability of active co-operation with a view of increasing the membership—a membership which, standing now at four hundred, should be at least a thousand before the year is out.

It has been suggested that the Advisory Committee of the Society, representing its interests with the officers of the Exhibition, and for other exhibition purposes, should consist of the present officers and all the living ex-presidents, namely:

Frank W. Jones,
John M. Pendleton,
Dr. Francis B. Crocker,
Joseph Wetzler,
C. O. Mailloux,
John W. Lieb, Jr.,
Dr. C. E. Emery,

all of whom, it is understood, will gladly co-operate in this movement to develop work, to which they themselves have so actively contributed in past years.

The following resolution was put to the meeting and adopted:

ELECTRICAL EXHIBITION.

RESOLVED: That having heard the report of the officers of the Society in regard to the arrangement effected for co-operation with the approaching Electrical Exhibition in this city, the members hereby express their hearty approval and pledge themselves to active work, that shall make the most of this opportunity for promoting the interests of electricity and the welfare of the society.

HENRY ELECTRICAL SOCIETY.

Rooms Nos. 111-115 West 38th street, New York.

The next meeting of the Henry Electrical Society will be held at Columbia University, Engineering Building, Room 302, on January 21, 1898, when Mr. D. R. Lovejoy will deliver a lecture on "The Induction Coil and High Potential Discharges."

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The lecture will treat of the practical design of the induction coil and will be illustrated by many experiments showing the various effects obtainable.

A D'ARSONVAL GALVANOMETER.

In an article written by Edward E. Sheldon for the American Electrician, entitled "Construction of a Galvanometer," some valuable detailed matter was given in connection with the appended illustrations, that related exclusively to the construction of a D'Arsonval galvanometer.

It may be interesting to some of our readers, not well versed in the technical side of this subject, to know that the Weston Electrical Instrument Company, of Newark, N. J., have made a success of the application of the D'Arsonval galvanometer, in the construction of volt and ampere meters. The working drawings of a galvanometer that will prove to be very serviceable are represented in the foregoing illustrations.

The base of the galvanometer, shown in figures 1 and 3, is made of hard wood or rubber. The supporting piece, shown in figure 2, is finished from a brass casting. The shape and dimensions of the same are given in both figures 1 and 2. The cylinder of soft iron supported between the poles of the magnet is attached to the standard as shown in figure 2, and the adjusting screw above which raises or lowers the coil surrounding this soft iron cylinder can be observed in figures 1 and 2. The coil is wound upon a framework of metal or fibre, the size of wire being No. 36, B. & S. A small mirror is attached, as shown in figure 1, above the coil.

Further details of value to the student desirous of constructing this instrument complete, may be found in full in the May, 1897, issue of the American Electrician.

Keokuk, Ia.—The Ottumwa Electric Railway—Judge Woolson has signed and filed a decree in the federal court ordering the sale of the electric road.

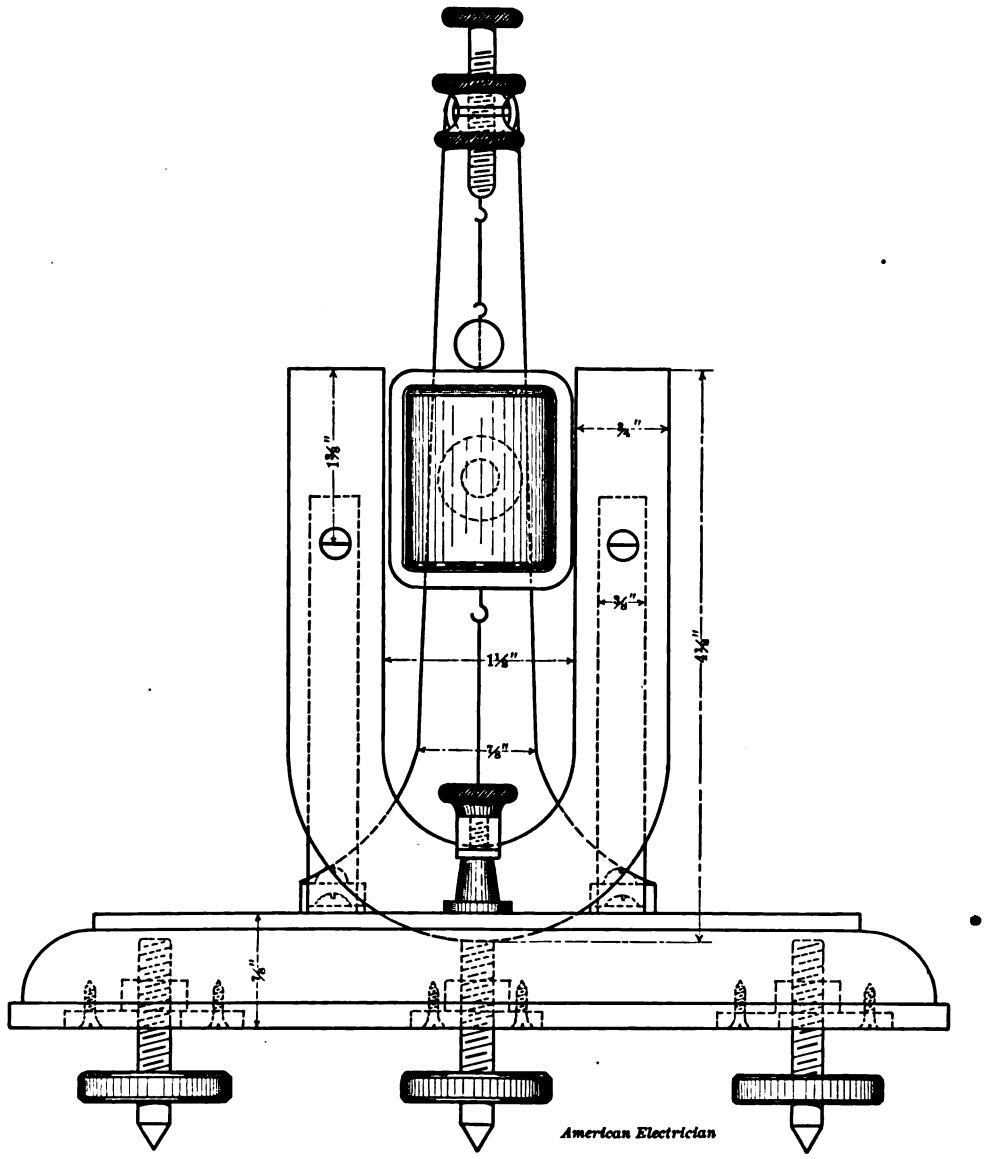

Fig. 1—D'Arsonval Galvanometer—Front View.

MEASUREMENT OF CAPACITY.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

Condensers in Series.—When a set of condensers of equal capacity are connected in series the capacity of the group is reduced, but the pressure increased.

With Capacities Equal.—When the condensers are of equal capacity, the capacity of all connected in series is equal to the capacity of one divided by the number.

With Capacities Unequal.—When the condensers have different capacities and are connected in series, the capacity of the whole is equal to the reciprocal of the sum of the reciprocals.

Represented in symbols

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$$K = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_3} + \text{etc.},}$$

where K = total capacity
K_1 = capacity of first condenser
K_2 = " second "
K_3 = " third "

Condensers in Parallel.—When condensers are connected in parallel the entire capacity is equal to the sum of the capacities.

Method of Direct Deflection.—The capacity of a condenser can be ascertained by reference to another condenser in a very simple manner.

In order that two charges may be compared, a galvanometer must be used whose deflection depends upon the amount of the charge sent through it.

A ballastic galvanometer serves this purpose to perfection. It does not differ in principle essentially from a reflecting galvanometer, except in regard to its swing. It swings very slowly when subjected to a sudden discharge from a condenser.

Method.—If two condensers of unequal capacity are to be compared, one must be known.

Instead of a condenser, the other may be a section of submarine cable, etc.

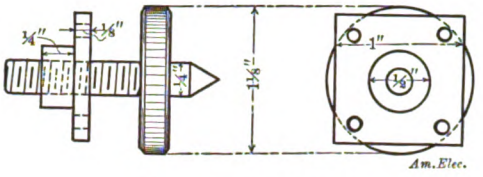

Fig. 4, Leveling Screw.

Both are charged by a constant E. M. F.—a standard cell, for instance.

When the condenser of known capacity is charged, it is discharged through the galvanometer and the deflection noted.

The other conductor or condenser of unknown capacity is likewise connected and discharged through the galvanometer. The charges are compared by means of the deflections, and the capacities correspond likewise.

Supposing a condenser of one-half a microfarad is charged by a standard Clark cell, when discharged the deflection

$$d_1 = 80;$$

with the condenser to be measured the deflection

$$d_2 = 200.$$

The rule states as follows: Capacity of the first : ca-

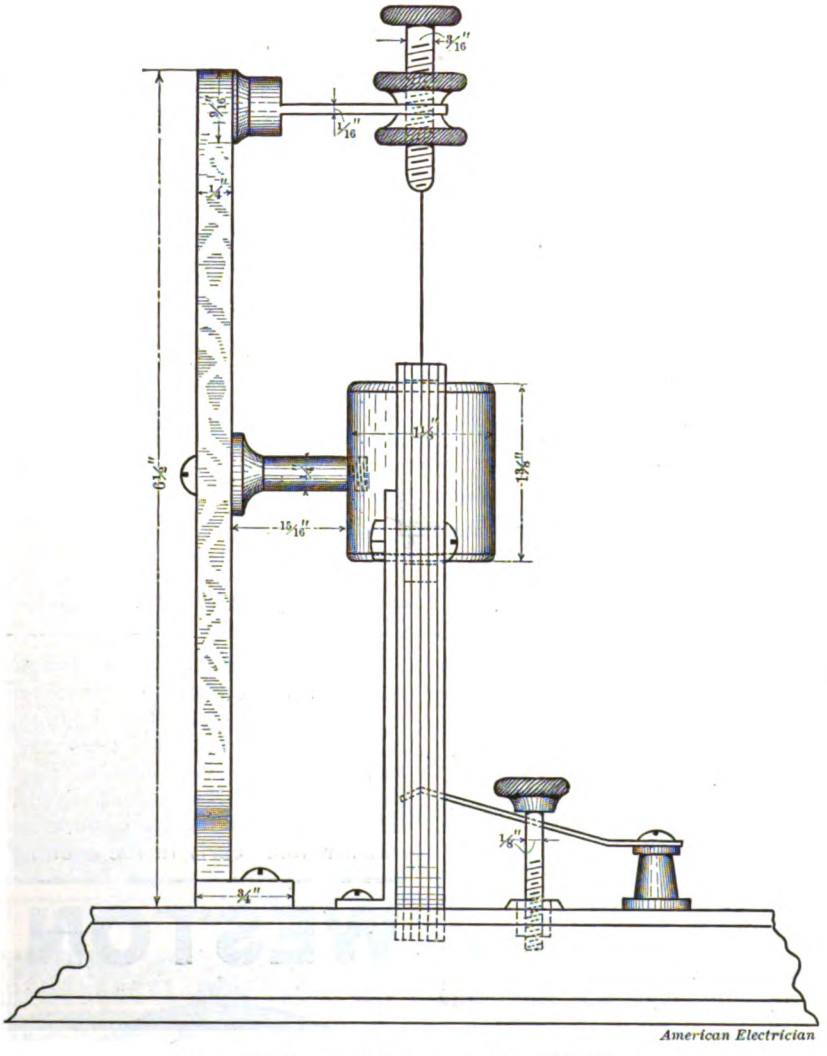

Fig. 2—D'Arsonval Galvanometer—Side View.

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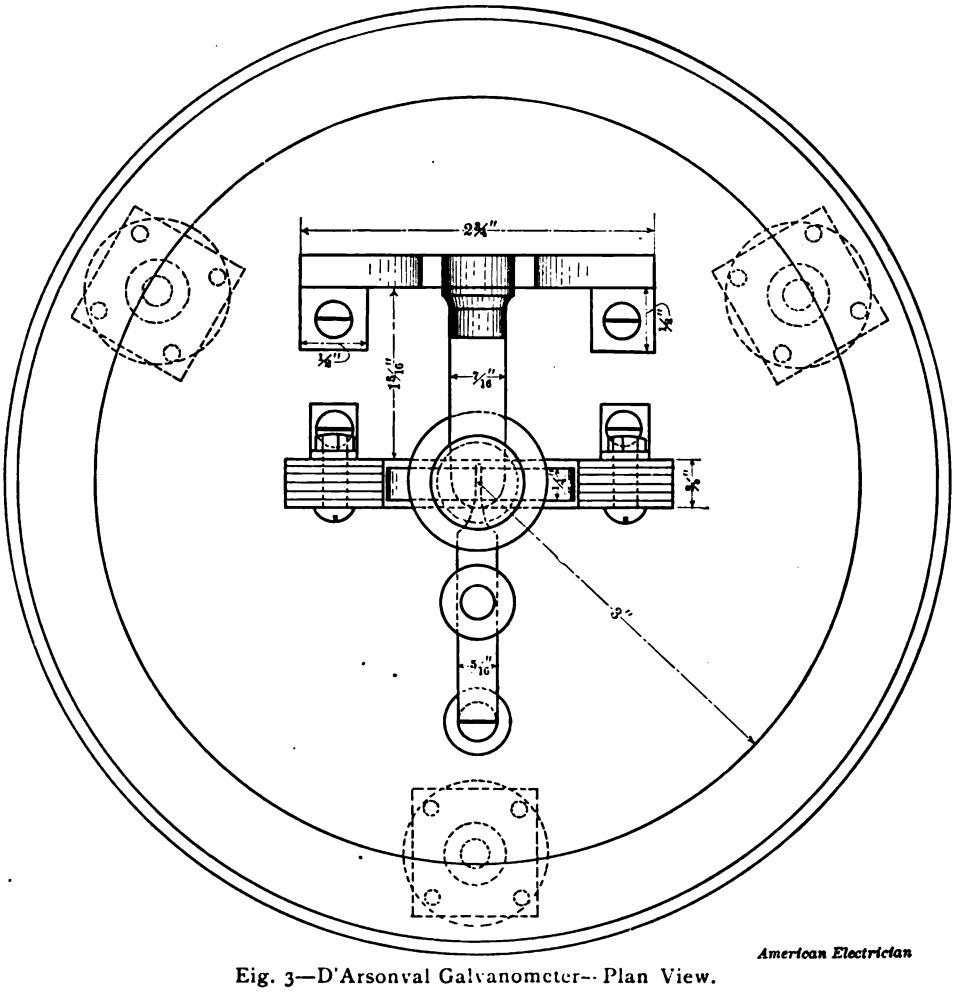
pacity of the second = first deflection : second deflection.

In symbols

$$F_1 : F_2 : = d_1 : d_2$$

F_1 = capacity of first condenser = ½ M. F.
F_2 = " to be determined.

There being no practical limit to the capacity of a body, the greater the pressure the greater the charge it will hold. In telephone practice the wire is surrounded by crinkled paper, and the insulation over that, to surround it with air if possible—air having a specific inductive capacity equal to unity—thus reducing the induction and consequent charge.



Eig. 3—D'Arsonval Galvanometer—Plan View.

d_1 = deflection due to ½ M. F.
d_2 = " " unknown capacity;

therefore,

$$F_1 = F_2 \times \frac{d_2}{d_1}$$

$$= \frac{1}{2} \times \frac{200}{80}$$

$$= 1.25 \text{ micro-farads.}$$

Condensers are generally made of alternate layers of tinfoil and mica, or tinfoil and paraffined paper.

A knot of cable about 1⅛ miles equals ⅓ microfarad capacity.

A condenser in many respects resembles a battery of very high internal resistance.

It has been discovered that condensers when exposed to a rapidly alternating electric current become heated. The paper if paraffined may dissolve the wax. This effect is due to dielectric hysteresis.

If the capacity of the great Atlantic cable could be reduced the passage of signals would be greatly accelerated. At present the cable must first be charged before a signal reaches the other end.

When alternating or interrupted currents are used a condenser prevents rapid communication; a coil of wire, if properly arranged in circuit, will in such a case neutralize its effect.

H. B. Crouse, of Crouse-Hinds Electric Co., of Syracuse, N. Y., makers of switches, switchboards, panelboards, etc., was in town January 15, closing up some big orders needing his personal attention. Mr. Crouse and Mr. F. M. Hawkins, of 39 Cortlandt street, N. Y., their Greater New York agent, were together doing Greater New York on important business. Mr. Crouse left for home early in the evening.

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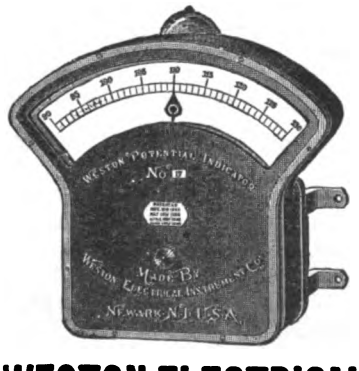

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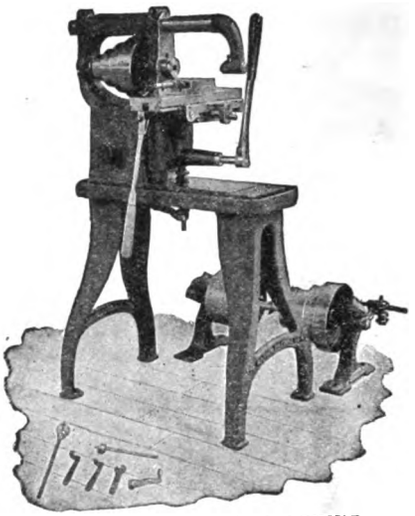

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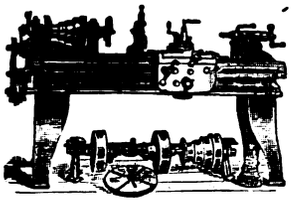

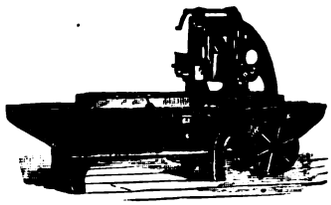

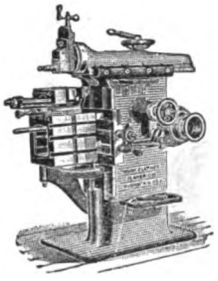

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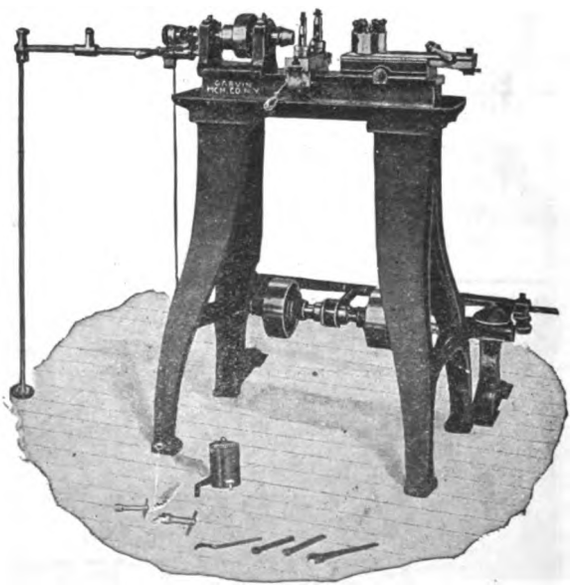

No. 00 SCREW MACHINE (WIRE FEED).

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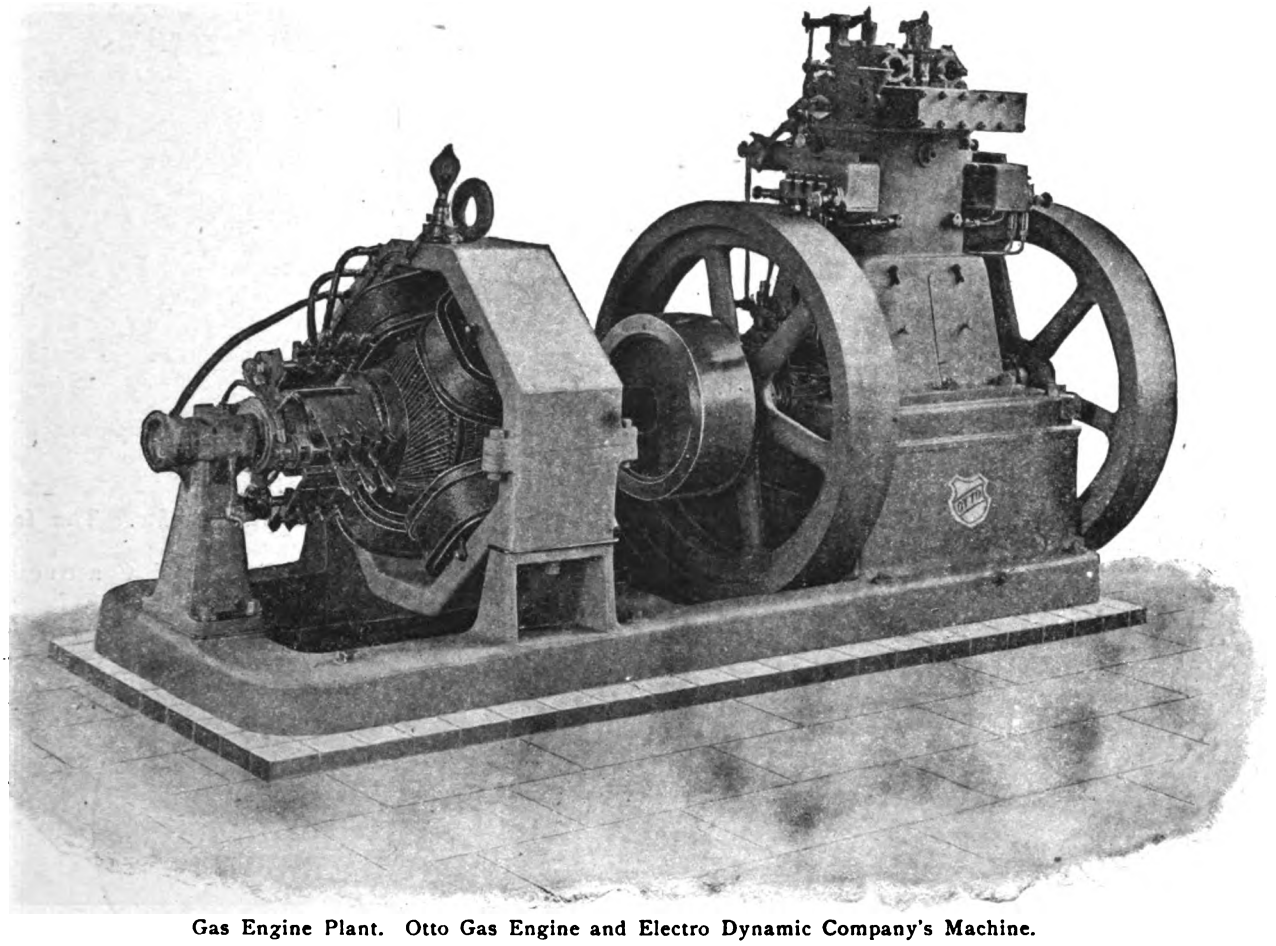
The Electrical Age.

VOL. XXI—No. 5 NEW YORK, JANUARY 29, 1898 WHOLE No. 559



Gas Engine Plant. Otto Gas Engine and Electro Dynamic Company's Machine.

THE ELECTRO DYNAMIC COMPANY.

It has often been said that the greatest inventions are generally the simplest ones. A highly ingenious device is being manufactured and sold by the Electro Dynamic Company, of 224 Chestnut street, Philadelphia, that will probably give rise to the remark on the part of electricians indicative of an immediate appreciation of its good qualities. The device is included among a list of marine specialties and is called an electric speed indicator. It is built upon a very simple principle, as follows: a permanent field is produced by a pair of steel magnets. An ironclad armature rotates in this field, being driven by the engine, whose speed it is to record. It is evident to the reader that electromotive force is directly proportional to speed in a field of constant intensity; therefore, by using a voltmeter or electric revolution indicator upon whose dial speed is marked instead of volts, the revolutions per minute of any piece of machinery, steam engine or otherwise, may be brought to the attention of more than one individual widely separated from each other at the same time.

The above device not only shows revolutions but also direction of rotation. The pointer rests normally at the middle of the scale and moves to the right or left according to the direction of rotation. For steamers using twin screws, it is possible to keep a record and have in constant view the revolutions of each engine. When both screws rotate at the same speed the rudder may be kept in its normal position between the two, and thus save an element of delay which in the aggregate may affect the vessel's time of landing. The indicators are enclosed in waterproof cases and may have their dials illuminated at night.

As an instance of the benefit of the helm angle indicator we would state that it has been found that on one of the record-breaking transatlantic liners, that by adjusting the speed of engines so that the helm could be maintained amidships, the lessening of friction resulted in a saving of two hours' time on a trip across.

Edco Dynamos.

The Electro Dynamic Company manufacture the well-known Edco dynamo, which has met with great success since the time of its introduction. They are economical, well designed and are capable of extended runs without heating or sparking or deterioration in any respect. They are built for either belt drive or direct connection. The field yokes are made of mild steel of very high permeability. The bearings are ring oilers. The important principle which should underlie the construction of all armatures has not been neglected by this company, but observed in their ironclad cool-running armatures; the rapid radiation of heat from the armature, to which we refer, has been so successfully accomplished that the safety factor is unusually large, thus enabling the consumer to call upon the machine without danger for high percentages of overload. The commutators are made of tempered copper, with high-grade mica insulation. The machines are of multipolar design, varying from ten amperes in a 115 volts through a series of 12 sizes to a six pole, 500 ampere, 115 volt generator.

An illustration is given of a direct-connected gas engine plant, consisting of a No. 26 "Otto" gas engine, running at 300 revolutions per minute, of 22-brake horsepower. The height from centre of shaft 40⅜ ins.; fly-

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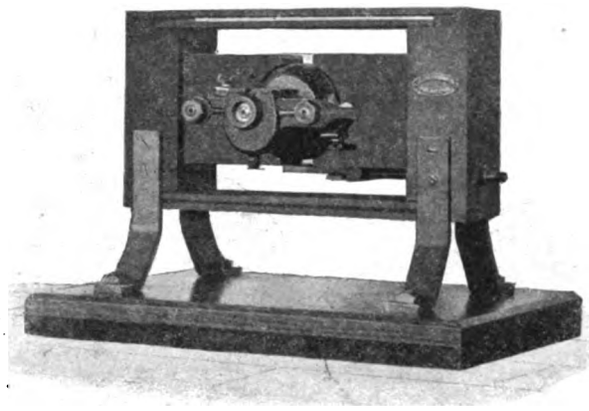
wheel, 32 ins. in diameter; weight, 2400 pounds. The generator is a 300-light machine, delivering 150 amperes, at 115 volts, of 17¼ k.w. at the normal of 400 revolutions per minute. The plant was installed in the home of Frank K. Thomson, president of the Pennsylvania Railroad, Philadelphia.



Generator of Electric Speed Indicator.

The Electro Dynamic Company built and sold electrical machinery in 1880, and is therefore familiar with every detail of construction, and is up to the times in the latest electrical and mechanical developments.

Electric Speed Indicator.

Electric Rudder Telltale.

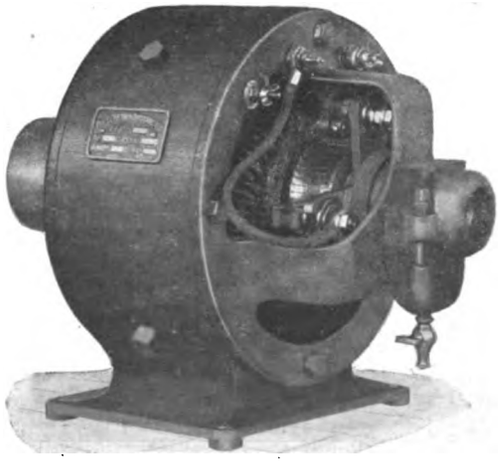
Electric Drill Motors.

They have been particularly successful with their portable electric drill motors with flexible shaft Its use means of 60 per cent. saving in labor, and its advantageous application for drilling in shipyards, boiler shops, and erecting shops of all kinds is substantiated by the nature of the communications received approving of its use and speaking highly of its benefits. The following letter speaks for itself:

NAVY DEPARTMENT, Bureau of Construction and Repair.

Washington, D. C., February 11, 1892.

Electro Dynamic Company,



Closed Type (Dust Proof) Multipolar Generator.

224 Chestnut street, Philadelphia, Pa.

Gentlemen:—Replying to your letter of the 6th instant, relative to the electric drill motors furnished by

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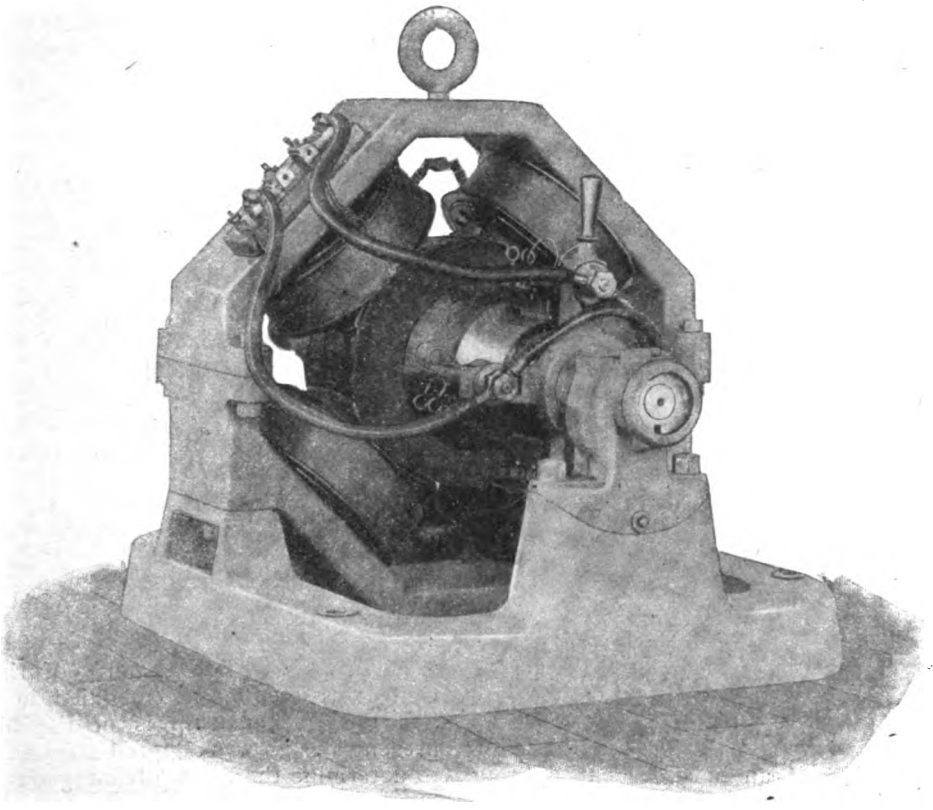
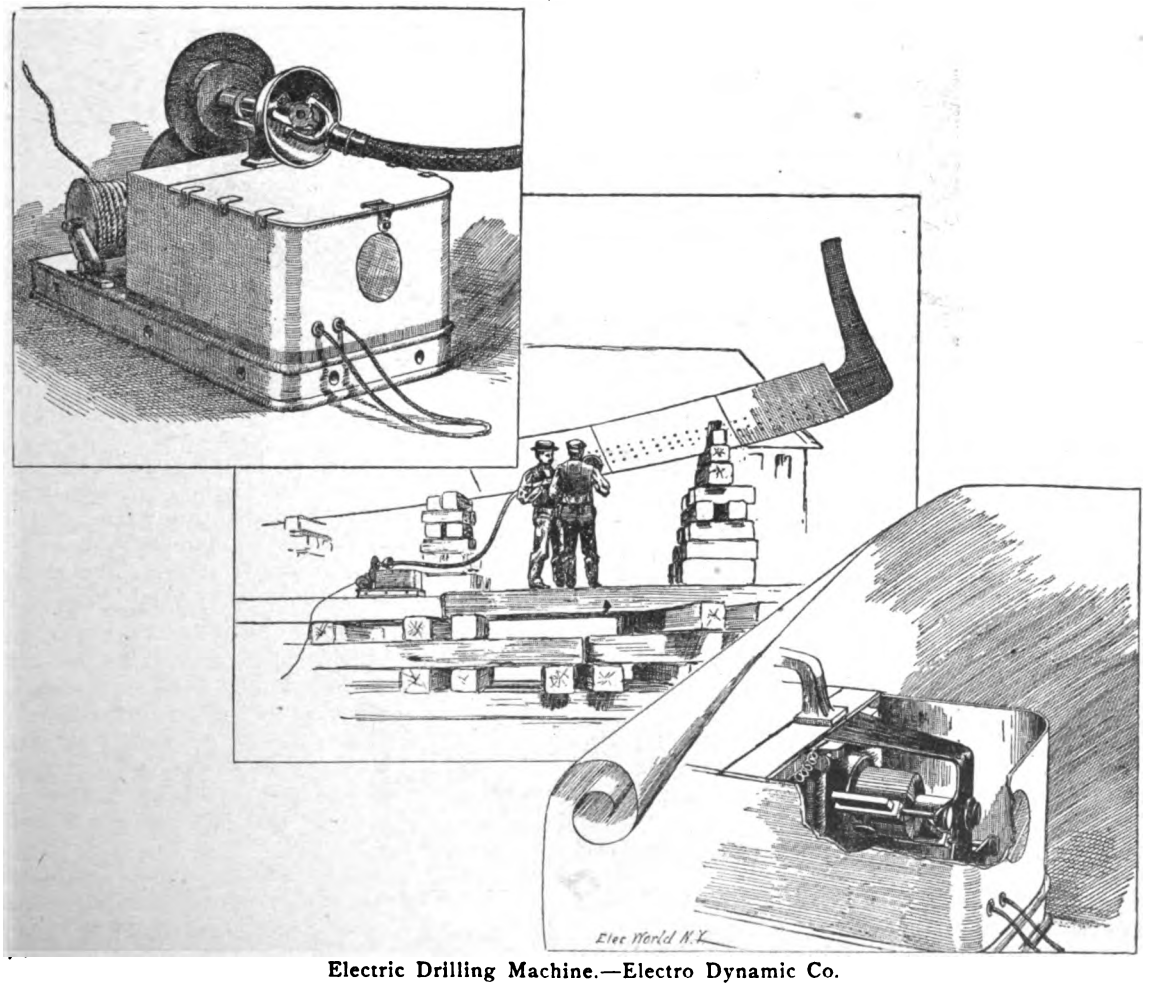
you to the Brooklyn Navy Yard, I would say that the motors gave entire satisfaction while I was stationed at the yard, and during the visits I have made there during the past year I have always found them at work, and heard the desirability of having more of them repeatedly expressed. In all heavy drilling required in naval vessels, the motors are particularly serviceable, and I believe there will be a large field for their use in drilling for side armor bolts of armored ships.



Open Type Multipolar Generator—Electro Dynamic Co.



Electric Drilling Machine.—Electro Dynamic Co.

I believe the 2 h.-p. type of motor, similar in its general features to that you built for the New York Navy Yard in 1888, is most suitable for general work, and that

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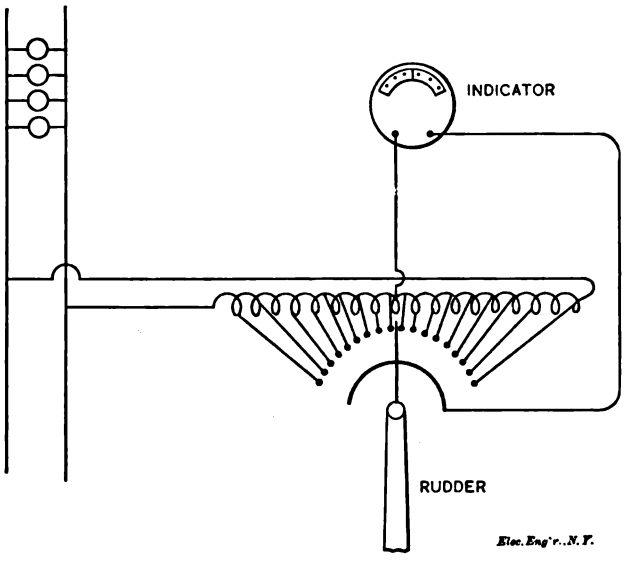
it will be seldom desirable to build the smaller sizes of motors, since the 2 h.-p. motor is light enough for all practical purposes of transportation in a ship yard.

Very respectfully,
J. J. WOODWARD,
Naval Constructor, U. S. N.



Electric Dynamic Co.

LAMP INSPECTOR'S INDICATING WATT-METER.

The successful operation of an incandescent lighting system depends largely upon the use of lamps of proper efficiency. To secure the most satisfactory service and highest economy, the efficiency of the lamps should be as high as the fluctuation of voltage on the circuits will permit. The selection of lamps for a particular installation should, therefore, be made with regard to the regulation rapidly the watts per candle-power required by a lamp, is of great value in selecting new lamps and in testing lamps in service. The General Electric Company has recently designed and introduced the Thomson Inclined Coil Portable Indicating Watt-Meter to meet an increasing demand for instruments of this class.

Fig. 4—Thomson Indicating Watt-Meter.

All of the well-known merits of the Thomson Inclined Coil Instruments are embodied in the new watt-meter and the workmanship is of the highest grade. The present design was adopted after numerous experiments to determine the most advantageous arrangement to facilitate rapid testing of lamps without inconvenience to their users. On account of the rapidity with which readings may be made, the indicating watt-meter will also be found invaluable for testing lamps in barrel lots either with or without the photometer. The watt-meter will accurately indicate the energy used by small fan motors

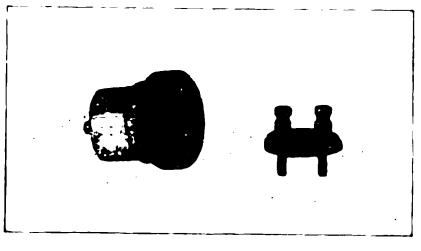


Fig 2—Secondary Attaching Plug.

obtained with the transformers in use. Efficiency is also the true basis for renewal of lamps, for it is manifestly uneconomical to continue a lamp in service when it has so deteriorated that the current it unnecessarily consumes costs more than a new lamp.

A portable instrument to determine accurately and and is, therefore, particularly useful in comparing, for a customer's benefit, the relative amount of energy required by a fan motor and an ordinary incandescent lamp. By supplying the secondary of a transformer with current, its core loss may be easily determined by the indicating watt-meter.

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For rapid connection the watt-meter is supplied with two special plugs, an Edison with T-H adapter, and a Westinghouse, thus providing ready means for connection to the three forms of sockets most generally in use. The lamp to be tested is inserted in one of the receptacles in the base of the instrument, and the proper plug placed in any convenient socket. Lead wires are provided suitably tipped at one end for insertion in the plugs and at the other for connection to the binding posts of the instrument. A small secondary plug arranged to fit the regular plugs and provided with two small binding posts, is also supplied with every instrument. With this convenient device the power required by small motors or other apparatus may be conveniently measured.

The capacity of the indicating watt-meter is 150 watts. Lamps of any candle-power up to 32 and of any voltage up to 150 may be tested, as may also any device, the consumption of energy in which is not over 150 watts at any voltage not exceeding 150.

The fact that the instrument is equally well adapted for use on either direct or alternating currents, necessitates the use of only one instrument in stations using both systems.

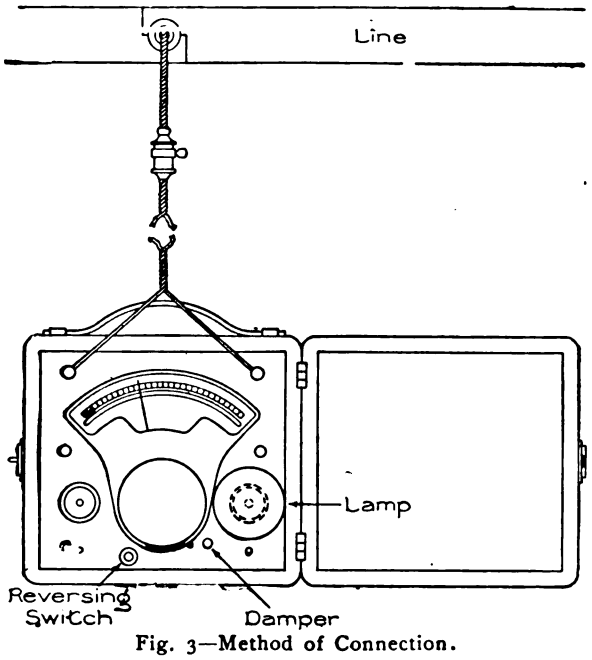

Fig. 3—Method of Connection.

On direct-current circuits reverse readings should be taken to eliminate the possibility of any slight error which may be introduced in all instruments of this class by the presence of local fields. A special reversing button is provided to reverse the current in the instrument and lamp without permitting the needle to fall back to zero. The usual convenience of reversing lead terminals is eliminated by the reversing button. When reversed readings are taken the mean of the two is, of course, taken as the final reading.

Another advantageous feature of the instrument is the damping device. A button is provided which releases the needle or pointer from the damping brake *only* when depressed. When the button is released the needle is held at the point of the last indication; therefore, if the current is turned off and then on again, or reversed, the necessity of waiting for the pointer to swing from zero to a state of rest is avoided and very rapid readings may be taken.

The terminals, reversing and damping buttons are mounted on a vulcanite baseboard above which the graduated dial slightly projects.

The instrument is mounted in a finely polished carrying case, with snap lock. It is light and compact, the external dimensions being 7⅜ in. x 7 in. x 4½ in. All parts are finished in polished nickel plate.

ELECTRIC LIGHT PLANT FOR THE BOROUGH OF NORRISTOWN, PA.

Sealed proposals will be received for an Electric Light Plant by the Finance Committee of the Borough Council of the Borough of Norristown, Pa., until 3 P. M., February 9th, 1898. Specifications and drawings will be delivered to bidders between the hours of 9 A. M. and 3 P. M., on and after January 25th, 1898.

The right is reserved to reject any and all bids, either in whole or in part, and to award the contract to other than the lowest bidder. Security will be required before specifications and drawings are delivered.

For particulars address Dr. W. A. Drysdale, Consulting Engineer, Hale Building, Philadelphia, Pa.

POWER FOR TONAWANDA.

North Tonawanda will have Niagara power early in the spring. This is the most important news that has been made public, in connection with the great electrical developments now going on along the Niagara frontier, since the announcement in December that power was ready for delivery in Buffalo for manufacturing and commercial purposes in practically unlimited quantities!

The Tonawanda Power and Conduit Company expects to be able to deliver the Falls energy to customers by May 1st, and perhaps sooner. Plans are already under way for building and equipping a power sub-station in North Tonawanda and work on the structure will be begun within a few weeks. Among the companies that are considering the use of Falls Power are the Tonawanda Lighting and Power Company and the Houix Manufacturing Company, which recently removed to North Tonawanda from Ohio.

In Buffalo there have been no important power developments since the last number of Greater Buffalo. The Cataract Power and Conduit Company has, however, received many applications for power from manufacturing and commercial establishments in nearly every part of the city.

The successful introduction of the electric current from the Falls into the Great Northern and Electric elevators has attracted attention all over the world, and has led several of the older elevators in the city to put in applications for power.

A number of manufacturing plants at Black Rock are

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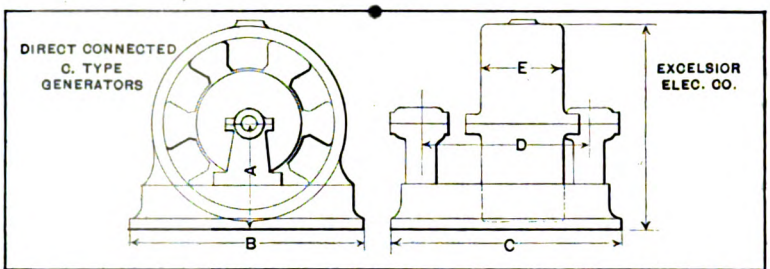
also figuring on the cost of the new power with a view to its exclusive use by them. Some important announcements in connection with the further use of the power in the city may be expected in the near future.

The Cataract Power and Conduit Company has awarded the contract for eleven step-down transformers to the General Electric Company of Schenectady. These transformers are for use in supplying Niagara power to the Buffalo General Electric Company's plant.—Greater Buffalo.



NO.	VOLTS	AMP.	K.W.	SPEED	A	B	C	D	E	F	G	DIAM. OF SHAFT
19			25	300	23	45	54	34	16	46		4
20			50	300	26½	58½	60½	40	16½	52½		5
21			75	300	26½	53½	60	49½	20	52½		5
22			100	250	35	68½	58½	44¾	20	70		6
23			150	250	35	68½	62½	48¾	24	70		6
24			200	225	35	68½	72½	58¾	32	70		7
25			300	200								

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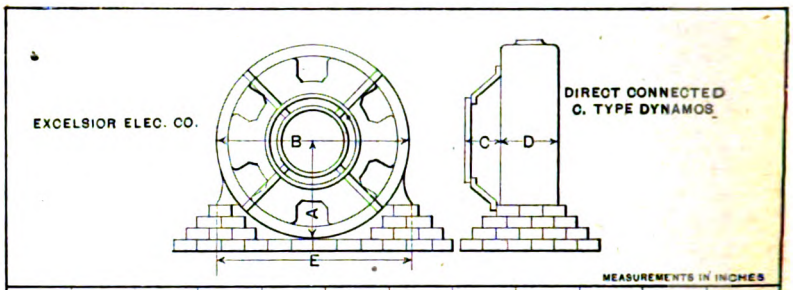
Direct-Current Direct-Connected Generator.

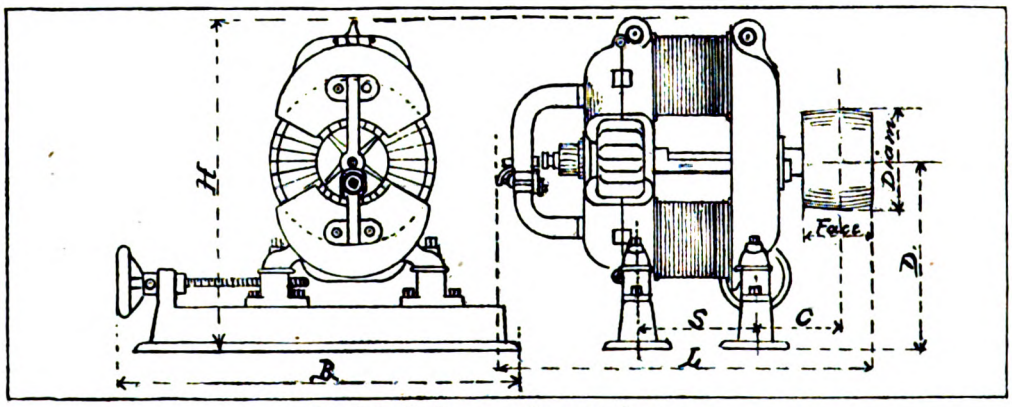


MEASUREMENTS IN INCHES

NO.	VOLTS	AMP.	K.W.	SPEED	A	B	C	D	E	F	DIAM. OF SHAFT
19			25	300	22	44	12	16	44		4
20			50	300	25½	51¾	14	16	50¾		5
21			75	300	25½	51¾	14	20	50½		6
22			100	250	34½	69	15	20	67		6
23			150	250	34½	69	16	24	67		7
24			200	225							
25			300	200							

Bartlett & Co., N.Y.

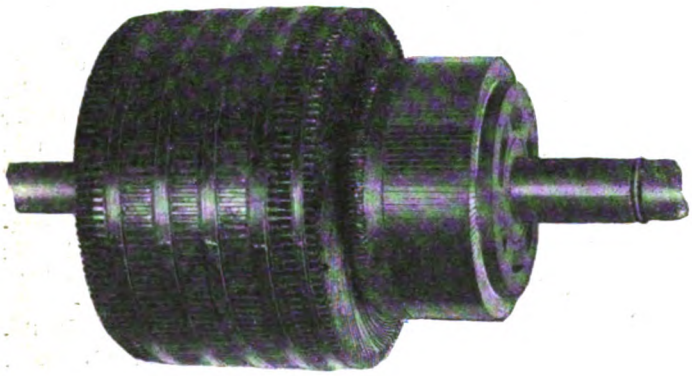
Direct-Current Direct-Connected Generator.



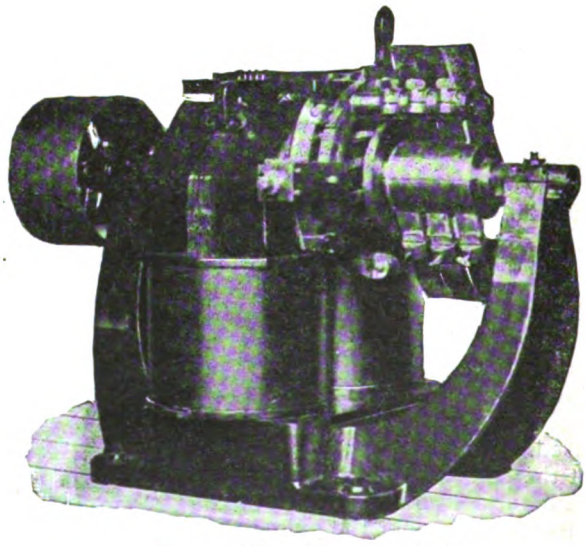
"Excelsior" Constant-Current Generator.

CHURCHWARD ELECTRICAL MACHINERY.

The Excelsior Electric Company, of 115 Broadway, New York City, have placed upon the market motors and dynamos whose superior qualities and high efficiency are a by-word among the trade. The design of these machines indicates a close acquaintance with the requirements of a good dynamo or an efficient motor. Armature reaction and demagnetization of pole-pieces have been reduced to a minimum. Sparking is entirely absent at all points of load and the loss by hysteresis and eddy currents in the armature core is negligible. The solidity and substantial appearance of the Excelsior Electric Company's machines appeal to the eye of every competent engineer. The relations between shaft and bearings, the position of the centre of gravity, the design of the base and the ease with which the machine can be assembled or taken apart are noteworthy features. The apparatus built by this company is interchangeable in every respect. Parts are readily replaced and a line dropped to either 115 Broadway or Monadnock Block, Chicago, Ill., will, if referring to a special part, receive immediate attention. A carbon brush-holder and frame made of one piece, a solidly built commutator and a capacity of twenty-five per cent. overload are recommendations of the most favorable nature. Constant-current generators for arc lighting, and power transmission are always in stock, likewise multipolar, direct-current dynamos for lighting, power



Finished Armature.



Plater of Excelsior Electric Co.

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ELECTRICITY FOR CANAL BOATS.

The Cataract General Electric Company held a meeting January 10, for the purpose of considering the means by which an electric cable way, sixty miles long, can be installed from Whitehall to West Troy, along the route of the Champlain Canal. The company's charter allows them to operate along the State canals and supply power, that is, electricity, to canal boats. The system considered will be one in which a trolley delivering power to motors hauling the boats will be installed. The proposition is merely one of an experimental nature and its success dependent entirely upon its cost and convenience. The motors dragging the boats will certainly do their work if the tractive force is sufficient. The use of a rack-and-pinion method, as advocated in the Schatz system, leaves no question of doubt open for discussion. Experiments in other directions are likely to fail and to be more expensive and less convenient. The fact that this work has been undertaken, however, is pleasant news and will certainly develop to an extent that can hardly be anticipated. Electricity on tap along the canals of New York State will so accelerate transportation of heavy freight, and the expense attached thereto, that it will make its citizens the most independent of any in the Union.

THE PATENT OFFICE.

Inventors frequently consider themselves abused, particularly when their application for a much coveted claim is denied. There is certainly a certain and peculiar condition of things which will sometimes enable an inventor to obtain what he calls his right or prevents him from making the progress he thinks his due.

The patent attorney occupies a peculiar position with respect to the inventor and the Washington office. He operates in the capacity of a strainer, receiving from the inventor a description and possibly a working model which he prunes down and so moulds as to be able to apply in the inventor's name for those rights which in the light of his experience may be granted. It happens in consequence, more or less frequently, that the claims allowed an inventor are but a small percentage of what he expected. If the article is manufactured, well and good, but if it is shelved indefinitely some other inventor, whose investigations have brought him in touch with the practical world and so stimulated his mind as to enable him to produce a new and useful article, may find his work interrupted and the total value of his claims greatly affected by the previous inventor, whose efforts have ceased and work shelved. The granting of a patent should not be entirely on the basis of a drawing but a demand made for a working model, or proof that a practical application of the apparatus is the end the inventor has in view. Unless satisfaction of this kind can be given to the patent office, claims should only be granted conditionally, that is, on the presumption that within five years use will be made of the idea thus monopolized. By this means the inventor intending to manufacture and possessing all the elements required for the commercial success of his crystallized ideas can make rapid headway, without being hampered by those that have merely glanced over the ground, selected a site but refused to build. The prosperity and commercial supremacy of the United States has been and is dependent upon the efforts of its inventors. The progress made in fields of engineering depends directly upon the happy conception flitting through the minds of inventors. But the fact that they frequently interfere with each other, infringe and enter into long and expensive litigations, if not individually, at least in the capacity of a corporation representative, seems to prove that the granting of so-called rights is like the sprinkling of legal gunpowder. Why should inventors lock up their patents? The law granting patents should be such that unless use is made of the claims granted within a specified time, less than seventeen years, regularly allowed, in all such cases a concern wishing to transact business and to manufacture an article, certain points of which are owned by this class of inventors, should be given the right to go ahead and thus add its mite to the general progress of the nation. The dog in the manger principle is utterly opposed to prosperity or any form of national advancement, either in the broad field of invention or commercial circles. To destroy its malign influence and give greater freedom to the good intentioned, the above modification of the patent law might have a lasting and happy effect.

IMPORTANT ELECTRICAL EXHIBITION ARRANGEMENTS.

Larger amounts of space are now taken up for the electrical show next May, the flow of applications is exhausting available space. Prof. F. B. Crocker has accepted the position of consulting engineer, on invitation of the management, which is desirous of associating with itself all that is best in regard to the technical side of the art. Prof. Crocker, who regards the exhibition as a highly useful means of reaching the public, is deeply interested in its success and wishful of promoting its beneficial influence in every way. His name as consulting engineer is a guarantee of good work being done under his supervision by the construction staff in the disposition and safeguarding of the exhibits. Prof. Crocker, as president of the American Institute of Electrical Engineers, and professor of electrical engineering at Columbia University, represents the highest technical skill known in the profession.

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and plating and alternating-current generators and motors. The above are built for moderate or slow speed as required—both motors. The Excelsior Electric Company is an old established firm, founded by an able electrician, and his work has been continued by Mr. Churchward, of equal ability. The design and construction of lighting and power machinery is therefore familiar to them in all its details.

ELECTROPLATING.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

PART I.

The essential requirements for electroplating are cleanliness and a slight knowledge of chemical reactions. There is much that may appear to be beyond the scope of the home experimenter in this work, but such is not the case, as the apparatus used is within the means of every careful worker.

The study of electrolysis is based upon the curious though familiar fact that the passage of a current through a solution made of the salts of any metal will cause a deposit to occur.

This deposit may be brought about by the current from a few small primary batteries of closed circuit type or the heavy current of a plating dynamo built and used especially for this purpose. The growing industry of electroplating has made this quite an important branch of the commercial arts. The most common department of plating is composed under the heads of copper, nickel and silver plating.

The more expanded use of these processes leads to the purification of ores by electrolysis, the extirpation of microbes and microscopic organisms from drinking water, and the treatment of sewage for the purpose of rendering it harmless from a hygienic standpoint and useful as a renovator of the soil.

The smelting of ores and the treatment of aluminum can almost be classed under the same head. The production of fine gold and silver ware, and the finer process of plating on glass, has created a new field in the application of electroplating to the higher arts.

And the sub-department of electrotyping in all its branches has been established on a firm footing in publishing and engraving firms.

Almost 100 years ago the first experiment, in the depositing of metals was performed in a small way, and from then on until forty years had passed the germ of growth was stayed.

The gradual evolution of the different methods now prevailing grew from that time on.

Electroplating is the process of depositing a layer of metal on another body by an electric current.

One of the simplest forms of plating coming into notice, and one within the scope of the reader, is the process of copperplating.

Copperplating.—A solution is made of pure water and crystals of sulphate of copper.

The copper crystals or bluestone, as it is commonly called, is dissolved in sufficient water to make a semi-saturated solution. The addition of a few drops of sulphuric acid greatly improves the conductivity of the bath. About four tumblerfuls of water to one-half a pound of crystals will suffice.

A plate of pure copper is secured to the positive pole of the battery or dynamo, and the object to be plated to the negative pole. The passage of the current will cover the object with a copper film of gradually increasing thickness.

The purity and excellence of the deposit is subject to the following conditions :

Pressure in volts.
Current in amperes.
Condition of solution.

Pressure in volts in copperplating is determined by the condition and nature of the bath.

A copper solution acidulated and a copper cyanide require the following :

	Volts.
Copper acid bath,	.5 to 1.5
Copper cyanide bath,	.3 to .5

The following facts in relation to copperplating will prove of value. The electro-chemical equivalent, or the amount of metal deposited by one ampere per second, is the basis of this table.

Simple Plating Cell.

COPPER.

			Weight in Grammes.
Current	1	ampere deposits	.000326 per second.
"	1	" "	.01957 " minute.
"	1	" "	1.17390 " hour.
"	851.8	" "	1. kilogramme per hour
"	386.4	" "	1. pound per hour.

The further facts worthy of consideration depend upon the extent to which the plating is done for their usefulness. When a great quantity of copper is to be deposited each day, the following is a valuable fact to remember :

One hundred pounds of copper deposited in a day of ten laboring hours would require 3,864 amperes of current.

To return to the process and precautions necessary—the material to be plated must be thoroughly free from grease and oil.

A coating of oxide sometimes forms from exposure to the air ; both can be removed by using two baths for cleansing, as mentioned below :

Stripping or acid bath.
Cleansing or lye "

PART II.

The stripping bath if used for a dip or two of the metal to be plated will remove all traces of oxide; in fact, it will act so successfully on a plated object that it will remove all the deposited metal in short order. The alkali bath of caustic soda attacks any and every form of grease, oil, etc., leaving the object clean and ready for a second cleansing in a vat of live water.

Metal, especially copper, can sometimes be deposited on a body due to the fact—the relation existing chemically will cause a coating of pure metal to form.

Bright steel dipped into a copper solution receives a red coat of copper, the metal being precipitated without the aid of any current. A weak current will deposit upon the cathode or negative pole a deposit that is inclined to be brittle and crystalline in nature.

A strong current will cause a deposit that appears to be composed of disintegrated particles of copper. They are black and powdery and of no use at all, though consisting of pure copper.

The proper current will give a characteristic deposit of tough and close-grained copper.

The determination of the proper current can be obtained by noting the current in amperes for a given surface of copper and regulating it as the table indicates.

Proper current for deposit.

	Amperes per 100 square inches.
Copper cyanide bath.....	2 to 3
Tough deposit.....	1.5 to 4
Very tough.....	4 to 10
Very solid.....	10 to 25
Solid, but sandy at edges.....	50 to 100

For weak solution and a strong current a black deposit ensues, and gas is liberated at the cathode pole.

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For a strong solution and a weak current the deposit is crystalline and useless.

It is sometimes considered good practice to connect a number of vats together in series; in such a case the volts required for the total number of baths on the basis given must be applied. For ten baths of three volts each 30 volts pressure is necessary. Plating can be done with a solution and a carbon anode.

If such were the case, however, the anode being unable to waste, the liquid would suffer, becoming greatly weakened, and unless strengthened by the addition of more salts ultimately losing all its metal, whether copper, nickel, silver or gold.

It is the practice to refine copper by using large vats in series with each other, as described. A dynamo of the requisite pressure sends the current through the series.

Huge blocks of the crude ore are connected to the positive pole and used as anodes.

The cathode is a thin plate of copper. Only pure copper is deposited upon it, and this is allowed to thicken until it is in the shape of thick plates or large ingots.

They are taken and rolled into wire or used for miscellaneous purposes, being about 96 to 98 per cent. pure copper.

The sediment or sludge is retained and the metal it holds, either in the shape of salts or particles, is recovered.

About three dollars' worth of gold and silver is obtained from each tank after a few days' run. The richness of the copper ore in these valuable impurities greatly varies, being from a dollar to three or even more per ton if the ore is rich.

Quicking a piece of metal is the process of covering its surface with mercury before plating. A solution made by dropping mercury into nitric acid will be useful for this purpose, if applied to the surface of the object.

When the article has received a coating of sufficient thickness it is removed from the bath and dried in sawdust, after being washed. It is then buffed, or, if the surface is rough, exposed to the action of a circular brush having wire instead of hair or bristles as its effective portion.

Scratching is the name applied to such work, and between the two the object becomes perfectly smooth and endowed with a bright lustre. To perfect the work further and produce a surface of excellent quality, the process of burnishing is carried on.

This is done by means of a smooth curved surface applied to the deposit very briskly and with considerable pressure. An object that has been covered with a coating of metal under which exists a surface of oxide is likely to peel. The way to eradicate this trouble is to treat the surface beforehand to a dilute solution of acid, or to give it a rapid dip in the stripping bath.

Certain classes of solutions do not conduct electricity very well, such as tetra-chloride of zinc for instance; nitrates in solution are very difficult to handle because of their rapid oxidizing power. The deposit of metal can only be obtained by the greatest care. The free acid released by electrolysis is the direct cause of the trouble. The best solutions are made up of sulphates or cyanides of the metal.

An excellent formula for a copper sulphate solution is as follows:

Acid copper solution.—Prepare a saturated solution of copper sulphate; warm water will be very effective in this respect for the rapid preparation of an intense solution.

Take 1 gallon of saturated solution.
1 quart of water.
1 ounce sulphuric acid.

The preparation of an alkaline solution for deposition upon iron and zinc is covered by the following:

Alkaline solution of copper.—Mix a solution of copper sulphate and cyanide of potassium together. A precipitate falls to the bottom of copper cyanide. The precipitate is washed in pure water and strained, then redissolved in a solution of cyanide of potassium and water.

A cyanide of potassium solution is made by dissolving two pounds of cyanide to one gallon of water.

After the copper solution has been obtained by the above method, two ounces of cyanide is added to each gallon of copper solution.

This solution works but at 100° F., but a heavy current will cause a good deposit at 30° F.

In nickelplating certain precautionary measures are adopted to insure good results. A very strong solution will be as injurious to the deposit as a heavy current. The solution and current therefore determine the quality of the deposit, while it is known that about 30 to 40 grains per hour of copper express the limit for good plating; the conditions of nickelplating forbid a similar statement.

Nickel is best deposited from a salt composed of two in active conjunction—salts of nickel and ammonium. The processes of preparation are two-fold; when separately obtained they are mixed as described.

(I.)

Sulphate of nickel.

3 parts nitric acid.
1 part sulphuric acid.
4 parts water.

Dissolve in this solution two pounds of nickel to each gallon and gradually heat until the nickel is entirely dissolved. When this occurs add one-quarter of its volume of hot water and filter.

(II.)

Ammonia solution.—Dissolve sulphate of ammonia in hot water until the solution is saturated; about four pounds to the gallon will be sufficient.

The two solutions of nickel and ammonia are mixed in equal quantities.

The precipitate that falls when both are mixed is then washed in a portion of the ammonia solution.

This sediment is the plating salt, the double salt of nickel and ammonia.

For use mix three-quarters of a pound of this salt to one gallon of water. The solution must be chemically neutral. This is accomplished by testing with litmus paper.

The paper is simply dipped in.

If the litmus paper becomes red add sulph. ammonia.
" " " blue " nickel.

QUESTIONS FOR REVIEW.

(1.) What is electroplating?
(2.) How is copper plating performed?
(3.) What affects the deposit?
(4.) What is the electro-chemical equivalent of a metal?
(5.) State the advantage of connecting vats in series.
(6.) How is copper refining carried on, and what are its benefits?
(7.) What is quicking?
What is scratching?
What is burnishing?

QUESTIONS FOR REVIEW.

Last week—On Capacity.

(1) What determines the capacity of an insulator?
(2) How can the quantity of electricity a condenser will hold be estimated?
(3) With E = 100 volts and F = 10, how many coulombs are absorbed?
(4) What is Specific Inductive Capacity?
(5) How is the capacity of a group of condensers affected by connecting them in series?

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(6) What is the formula for calculating the capacity of a set of condensers in series? In multiple?

(7) Explain the method of obtaining the capacity of a condenser by comparison.

EDISON, JR., INCANDESCENT LAMP EFFICIENCY TEST.

Test of Edison, Jr.'s 55 volt 3½-watt lamp, ordinarily using $\frac{9}{10}$ of an ampere at 55 volts.

One of these lamps was put on a 117-volt circuit and

ran for eight minutes without injury to the lamp. This lamp was shown in competition with a new arc lamp just installed in the Schermerhorn Building, 96 Broadway, in Mr. Thos. A. Edison Jr.'s office. The Edison, Jr., 55-volt lamp gave the greatest amount of light during the test of eight minutes. Mr. Swann, of the Swann Manufacturing Co., 123 Liberty street, N. Y., frosted one of these 55-volt lamps for test. It was tried on the 117-volt circuit and was still burning when the representative of the Electrical Age left the office twenty-five minutes afterwards at the same brilliancy. You could not keep your eye on the lamp for a moment without seeing all kinds of stars. There is no doubt but that the lamp was up to 2,000 c. p., showing the high efficiency and long life of the Edison, Jr., lamps. No other maker of lamps have shown the efficiency and life on similar test. This test also shows the remarkable strain the carbon can stand without injury.

W. T. H.

SPARKING, ITS CAUSE AND EFFECTS.

(Continued from page 46.)

Perfect commutation for any particular position of the brushes can therefore only take place at one value of the load. At heavier loads than this critical one the current is not completely reversed before the segment leaves the brush and at lighter loads it is more than reversed. This problem may be stated a little more precisely in the following manner :—

Assume that the brushes are set as far back as is consistent with sparkless running at the maximum load at which the machine is required to run sparklessly. This means that the reversal E is just equal to the coil impedance E at that point. Now let the load be removed gradually. The impedance E of the coil under commutation is reduced while the reversal E remains practically constant. The tendency is therefore for the current to be more than reversed, and this tendency increases as the load is reduced, until finally, when the load has been removed entirely, there is no current to reverse, and the reversal E simply tends to produce a current in the coil under commutation. The production of this current is now opposed by the inductance and resistance of the coil, and by the resistance of the brush contact surfaces, the contact surfaces of the two segments being in series as regards this current. If the impedance of the coil is low as compared with this contact resistance, the reversal E would be small compared with the CR drop across the contact surfaces at full-load current. Therefore the current produced by the reversal E would be small as compared with the full-load current.

We may also note here, that, whereas the variation of the contact resistances aids the reversal of the current, as soon as this current becomes greater than that which flows through the armature, the excess current must pass across the contact areas of both the segments under the brush. The resistance of these two surfaces are then placed in series as regards this current, and the lowest possible resistance that these could have, would be reached when the brush covers an equal surface on each segment, making the contact resistance in the path of

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this current equal to twice the resistance of the contact surface of either segment at that time. The resistance of this path then starts at infinity, decreases to this minimum and goes back to infinity again.

Now examine more closely the order of events in commutation at no load. The resistance of the coil circuit first starts at infinity and rapidly decreases, while the reversal E starts at a minimum and more slowly increases. As soon as a current commences to flow, inductance T enters the problem. If there were no contact resistance, the current would reach its formal full-load value at about the middle of the commutation period. This, of course, assumes that the reversal E is of such a magnitude as to reverse the current at full load without the aid of the varying contact resistances. In fact the reversal E does a very small part of the reversing at full load when the inductance is small compared with the contact resistances. The current at the middle of the commutation period would therefore be much smaller than the normal full-load current, even if there were no contact resistance to limit it. Now introducing this contact resistance, which starts at infinity and decreases to a minimum, which may be several times greater than the impedance of the coil, the current must be reduced at least in the proportion of the impedance to this minimum resistance. During the rest of that period the resistadce is increasing till at the end it has reached infinity again. The current, already very small, is rapidly cut down till it is too small to produce a visible spark at the break, and the commutator has not been heated up enough at any point to produce arcing.

The same principles hold in the case of machines whose brushes must be shifted, the range of sparkless commutation only being less.

There have been some machines, however, which would not run sparklessly for any position of the brushes. This is readily explained on the hypothesis of too high an impedance, for in that case the variation of the current during commutation will be mainly governed by the impedance and reversal E, instead of by the variation of the contact resistances, so that even if complete reversal is exactly attained, the current density at other parts of the commutation period does not remain constant, with the result that the total energy of commuation is increased. A large part of this energy is concentrated at the beginning and end of the commutation period, thus producing heating at the edges of the segments with its corresponding melting of the copper and arcing.

These considerations indicate two ways by which sparkless commutation may be assured. First by increasing the brush contact resistance, and second by decreasing the impedance of the coil under commutation.

The limitation of the second of these conditions is merely one of economical design, lowering of the inductance below a certain point increasing the cost of the machine.

The limitation of the first condition is that of rise ot temperature of the commutator. It has been shown that for perfect commutation the current density is constant and uniform throughout the whole period of commutation. Its value is found by dividing the total brush current by the contact area of the segments under a brush. This varies inversely with the brush contact area, and the energy developed therefore varies in the same proportion. The amount of commutator metal to be heated, as well as the radiating surface, also varies inversely with the current density so that the rise of temperature probably varies nearly as the square of the current density, provided the commutation be practically perfect.

The increasing use of the carbon brush in place of the copper brush is thus explained by the fact that the contact resistance of carbon on copper per square inch is much greater than that of copper on copper. Increased resistance is obtained with the copper brush by reducing its contact area, but this also reduces the metal to be heated in the commutator, as well as its radiating surface, so that the same amount of commutating energy will result in a much greater rise of temperature.

By taking these facts into consideration, however, and properly proportioning the contact areas and inductance, commutating machines may be designed to run as cool with copper brushes as with carbon wherever this may be desirable.

The reasoning so far has been based on the assumption of but one coil being commutated at a time. This assumption will only be true when the brush thickness is equal to, or less than the width of one segment, plus twice the thickness of the insulation between segments. In practice, brushes are often made to cover a segment and a half, sometimes two segments or even more than this without deleterious sparking. This means that the current in two or more coils is being commutated at the same time.

(To be continued.)

New York.

Newton Harrison, E. E., Electrical Age Publishing Company, World Building, New York City.

Dear Sir:—I have received a copy of the Electrical Age from some unknown source. I have an idea that you kindly sent it to me. Be this so or not, let me congratulate you on the general appearance of the paper, and particularly on the more than ordinary excellence of its editorial commentaries and the articles which engendered them.

Wishing you every success in your undertaking, I am,

Very truly yours,

DR. OTTO A. MOSES,

Cable Address: Florian. 49 Exchange Place.

West Chester, Pa.—The Philadelphia and West Chester Electric Railway is to be extended from Newtown Square.

New York, N. Y.—The Colonial Electric Co. has been incorporated to furnish heat, light and power. Capital stock, $25,000.

Harrietstown, N. Y.—The Saranac Lake Light, Heat and Power Co. has been incorporated by P. A. Gould and others.

New Orleans, La.—The People's Telephone Co. has been incorporated with George N. Norton, president; Wm. P. Curtis, vice-president.

Philadelphia, Pa.—Valle Bros. & Co., electrical supplies. New firm, same style.

Battle Creek, Mich.—An electric railroad will probably be built from Battle Creek, through Barry county, to Grand Rapids.

Bloomfield, Ia.—City clerk may be addressed concerning establishment of a telephone exchange.

Farmington, Mich.—An electric road will probably be built to Farmington.

Denver, Col.—Louis Enricht has been awarded contract for the construction of the Canon City & Cripple Creek electric road.

Lexington, Va.—The Spottswood Telephone Co. are adding many improvements to their line.

Maysville, Mo.—Frank Costello and Charles Lytle have been granted a telephone franchise.

St. Louis, Mo.—The Missouri Electric Light and Power Co. and the Edison Electrical Co. have consolidated, under title of Missouri Edison Electric Co. The new company will, it is reported, issue $4,000,000 of gold-bearing bonds.

Corbin, Ky.—An electric light plant will be established.

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NEW ELECTRICAL INCORPORATIONS.

Albany, N. Y.—The New York and Staten Island Electric Co. has filed a certificate of increase of capital stock from $500,000 to $1,500,000.

Hyattsville, Md.—An electric light plant will be erected, and funds will be raised for same.

Hyattsville, Md.—A telephone line has been completed from Hyattsville to the Maryland Agricultural College at College Park.

Everett, Mass.—The West End Street Railway car-house was destroyed by fire recently, together with ninety electric cars. The loss on the building is estimated at about $30,000, and on the cars at $120,000.

Harrisburg, Pa.—The Pennsylvania Electric Co., of Marietta, has been incorporated by E. Burd Cassel, H. L. Haideman, E. L. Reinhold, H. S. Rich, Marietta; E. H. Hershey, J H. Myers; to manufacture and sell all kinds of electrical and electric mechanical appliances. Capital stock, $25,000.

Corunna, Mich.—Clarence Hawley, of Detroit, has been granted franchise for an electric light plant for Corunna.

Baldwinsville, N. Y.—Baldwinsville Telephone Co. has been incorporated by Wm. F. Morris, Horam Howard, and W. H. Tappan. Capital stock, $10,000.

Minneapolis, Minn.—The Gladstone Electric Lighting and Power Co. petition of the stockholders for the dissolution of the company has been granted.

Fort Wayne, Ind.—The Fort Wayne Electric Company contemplates the erection of an addition to its plant.

Chicago, Ill.—The Western Electric Co. will make extensive additions to its factory.

Baltimore, Md.—The Consumers Ice Co., August Fenneman, President, will erect an electric light plant to supply Electric Park at Arlington.

Baltimore, Md.—The Baltimore, Annapolis & Drum Point Telephone Co. has been incorporated by George Weems, Williams, and Frank R. Biedler, John B. Gray and William H. Hellen and others. Capital stock, $12,500.

Topeka, Kan.—The Kansas City, Lawrence & Topeka Electric Railway and Power Co., incorporated, to construct an electric line between Kansas City and Law-

FRANCIS BROS. & JELLETT, incorporated, contracting engineers, 704 Arch street, Philadelphia, St. Paul Building, New York City, have removed their offices from the St. Paul Building to Nos. 70 & 72 Trinity Place, where they will have ample room for the conduct of their business. By this move they will combine their offices, drawing-room and shop, giving them a closer oversight over their work. They will be better equipped to do jobbing work and for making repairs promptly. They make a specialty of the better class of steam heating and ventilating, and undertake to furnish and erect complete mechanical plants for buildings of any size and for all purposes.

They solicit an opportunity of submitting estimates and can give satisfactory references as to their ability and financial standing. Telephone connection.

ONE HOUR BY RAIL TO PHILADELPHIA.

[From the Journal, Jannary 25.]

One hour to Philadelphia on an electric railroad from Jersey City, is the latest project. The Central Railroad of New Jersey is behind the scheme. The controlling stockholders of the Jersey Central will furnish the bulk of the capital for the new venture and the Jersey Central tracks will be used for the greater portion of the way.

An old elevated railroad franchise, which permits the building of a road from the Jersey City terminal, at Communipaw, to Jersey City Heights, has been secured by parties representing the Jersey Central Company. This road will be extended over the meadows to Newark, and by use of the Jersey Central tracks part of the way, and new tracks where a shorter route can be built, the line will be extended through Trenton to Philadelphia.

The third-rail, Watkins alternating system will be used, whereby a speed of more than eighty miles an hour can be attained The principal difficulty with the electric third-rail system along surface roads lies in the danger to life from the highly charged electric rail. This difficulty has been overcome by a late improvement which leaves the rail charged with electricity only when the car is passing over it. This invention also permits the power to be utilized for 300 miles instead of 15 miles, as heretofore.

The ostensible promoters of the scheme are Charles N. King, secretary of the New Jersey Corporations' Agency; Postmaster Robert Jordan and Garrett Van Horn, who originally owned the "L" road franchise. These gentlemen are believed to be acting for the Jersey Central Railroad. They all declined to talk in reference to the matter, although they admitted that the "L" road was to be constructed and that it was not merely for the purpose of connecting Jersey City Heights with the Jersey Central Ferry.

Strange as it may seem, there is no way by which residents of lower Jersey City and Jersey City Heights can reach the Jersey City Ferry now except by going to New York or paddling across a sheet of water in an old scow.

The trolley roads have cut heavily into the Jersey Central's business to Newark, and even beyond that point.

The "L" road will tap the most populous districts of Jersey City and at the same time afford the most rapid route to the principal towns through the State of New Jersey, while the main line can be used for ordinary passenger business and the freight and local traffic.

There have been rumors in Wall street that the Jersey Central is to become an integral part of a trunk line to Buffalo and Chicago, in which the Buffalo, Rochester & Pittsburg and the Wheeling & Lake Erie will be links. It was impossible to ascertain, however, whether the new electric line to Philadelphia, under the auspices of the Jersey Central, was only a part of the greater trunk-line scheme.

The Watkins third-rail system has already been tried on a section of the New York, New Haven & Hartford line, where a speed of eighty miles was attained without the later improvements.

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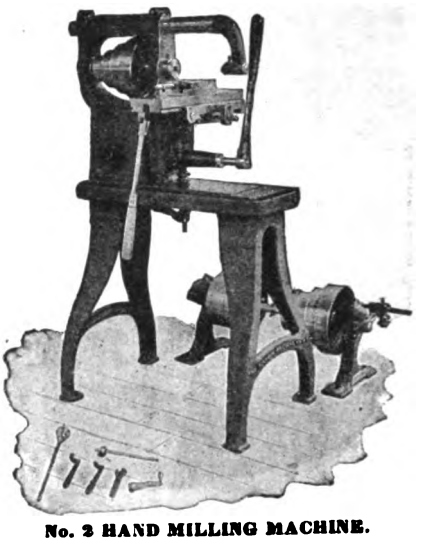

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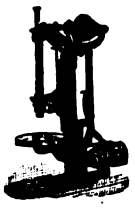

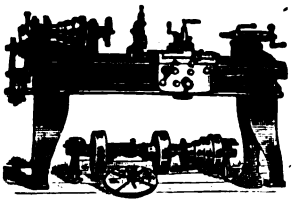

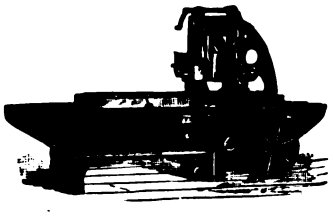

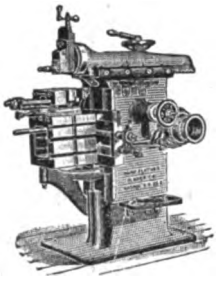

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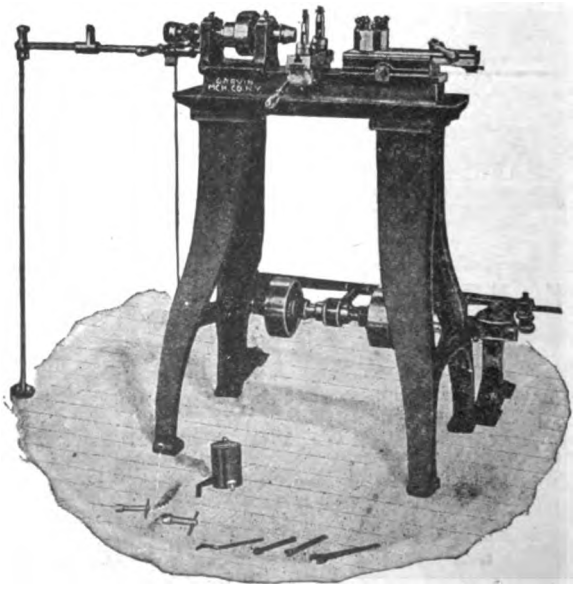

No. 00 SCREW MACHINE (WIRE FEED).

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The Electrical Age.

VOL. XXI—No. 6 NEW YORK, FEBRUARY 5, 1898 WHOLE No. 560

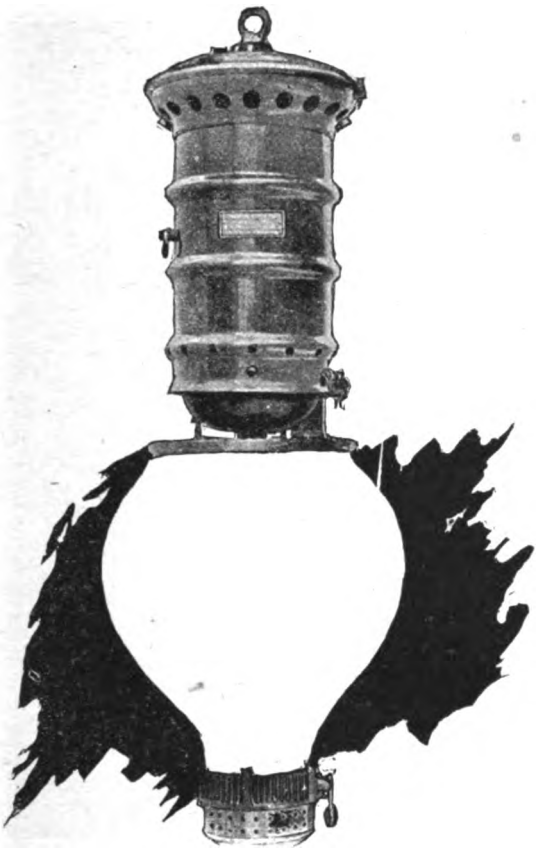

Fig. I.

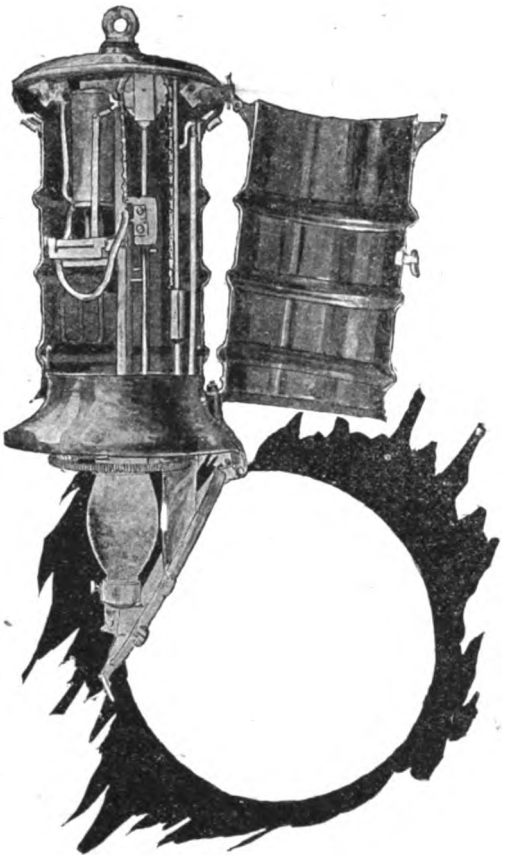

Fig. II.

THE WALKER ARC LAMP.

Like the dynamo, the arc lamp is now a well understood principle and almost anyone can make an arc lamp that will operate. There are, however, many desirable features which involve both workmanship and principle. In setting forth the features of this arc lamp, the Walker Company respectfully invites comparison with the product of other makers, and judgment as to whether these desirable features have not been realized in the highest degree.

Length.—The public now demand a short arc lamp, and unless a lamp has this feature it may as well stay out of the market. It is obvious that the minimum length of a lamp using straight carbons is that of a fresh trimming, and if the lamp is but a few inches longer than the total length of the carbons that it feeds the most critical could not reasonably ask for more. The length of a fresh trimming of carbons for the Walker arc lamp is 26 inches, and the total length of the lamp is 34¼ inches. Thus the percentage of increase is only 32 per cent., and when it is realized that many lamps are 150 per cent. longer than the carbon that they feed, it cannot be contested that the Walker arc lamp is notably excellent in this respect. After a careful measurement of the length of similar types, it can be safely said that the Walker lamp is shorter than any other burning the same length of carbons under the same conditions.

Workmanship.—It would be very foolish for the Walker Company to compromise its reputation for excellent workmanship by producing an arc lamp that was inferior. As regards workmanship, the words "Walker" and "best" have been and always will be synonymous.

General Appearance.—It will be seen from the cut of the lamp (fig. 1) that it is a solid and substantial affair, but is susceptible of highly decorative design. The figure depicts a lamp for outdoor service and places where an ornamental lamp is not necessary. Being newly on the market there has not been time to devote to this feature of decorative appearance, which for the most part is a mere matter of the shape and material of the case, but shortly there will be offered an assortment in which the most critical æsthete can find something to gratify his tastes.

Mechanism.—This is, of course, the most important part of the lamp, and in order to appreciate it better a brief discussion of general principles is necessary. There are two great classes of lamps, one of which feeds by a rack and pinion connected with an escapement, and the other with a smooth rod and clutch. The working of the former is admittedly superior to the latter when both are in good order, but the complications of the rack-feed lamp make it undesirable from a point of maintenance. The principle of the clutch lamp is as perfect as that of the rack lamp, but owing to the difficulty of producing rods that were both smooth and straight and clutches that would grasp with equal friction on any part of them, the lamp has never been able to burn with the same steadiness that the rack lamp does when it is in good order. The clutch lamp had the good feature that it was much harder to totally disable, because it was more simple.

The Walker Arc Lamp has been designed with the idea of obtaining the steadiness of the rack feed, and the simplicity of the clutch. The solution of the problem was a theoretically perfect clutch lamp. It was realized at once that the rod was the cause of much trouble and it was done away with, and in its place was substituted a

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wheel of small diameter with an accurately turned rim, on the edge of which the clutch operated. Such a clutching surface it is almost impossible to spring out of true, or mar, as is easily done, and frequently happens with a rod. The carbons are fed by a chain, as shown in figure

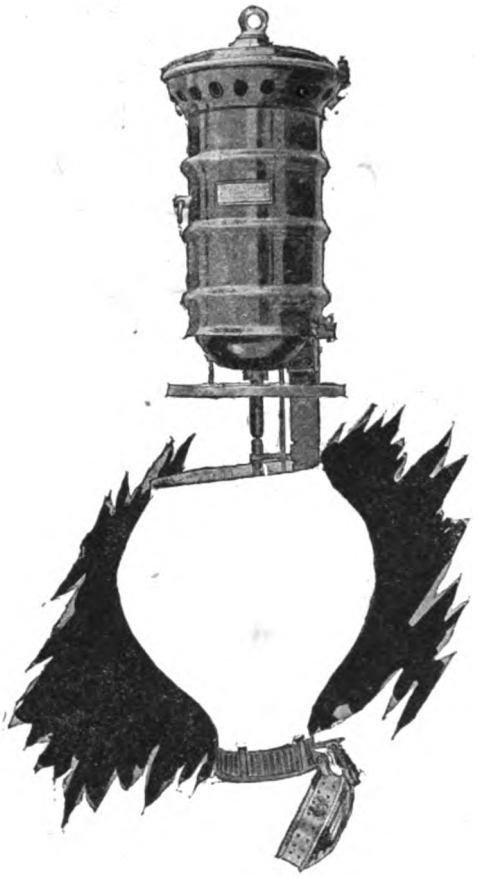

Fig. III.

2, and this chain drives a sprocket wheel, mounted on the same spindle that carries the clutch wheel. Both carbons are fed, and the arc remains practically station-

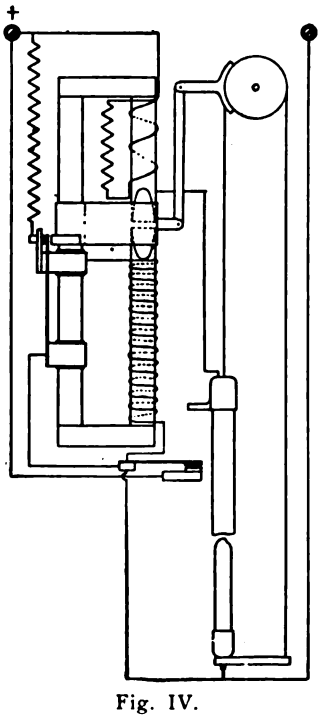

Fig. IV.

ary. The next improvement was to connect both carbons positively with their sources of supply by means of flexible cables. In most arc lamps the current is transmitted to the carbons through some part of the moving mechanism, and in many cases the absurd device of using a brush against the surface to be clutched is employed. Sparking and imperfect action of the clutch is sure to follow.

We next come to the electromagnetic mechanism controlling the clutch. This is very simple. It is mechanically differential mechanism, that is, the series bobbin and the shunt bobbin are separate and pull in opposite directions on the same armature. The electro-magnet is shown in diagram in Fig. 4. The armature is cleft at

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its extremity, and this cleft travels over the wedge-shaped cores of the series or shunt bobbins, according as the one or the other predominates.

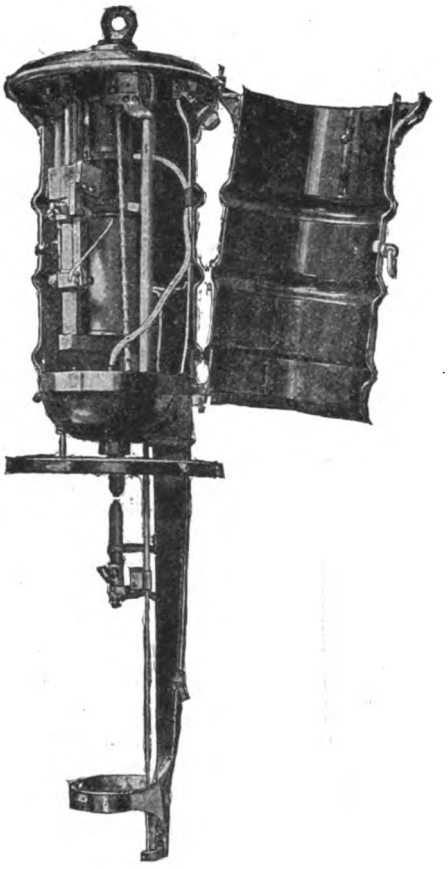
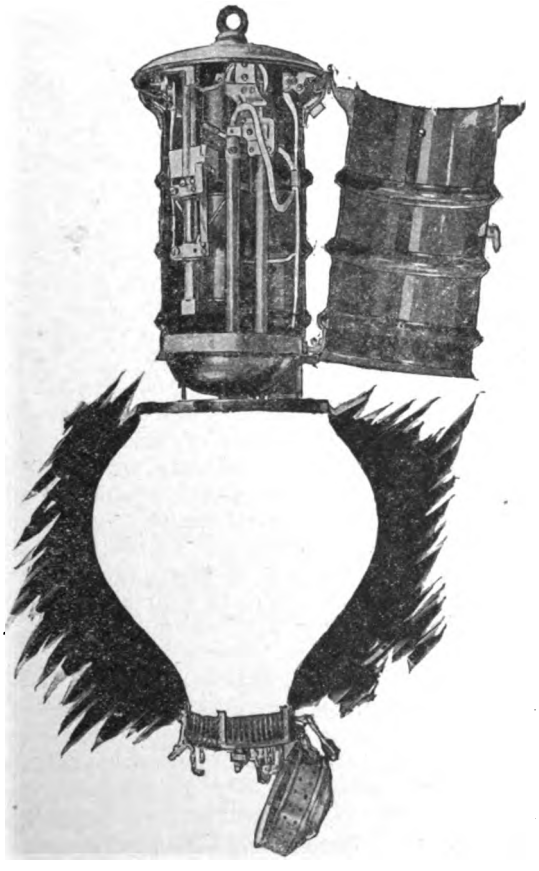
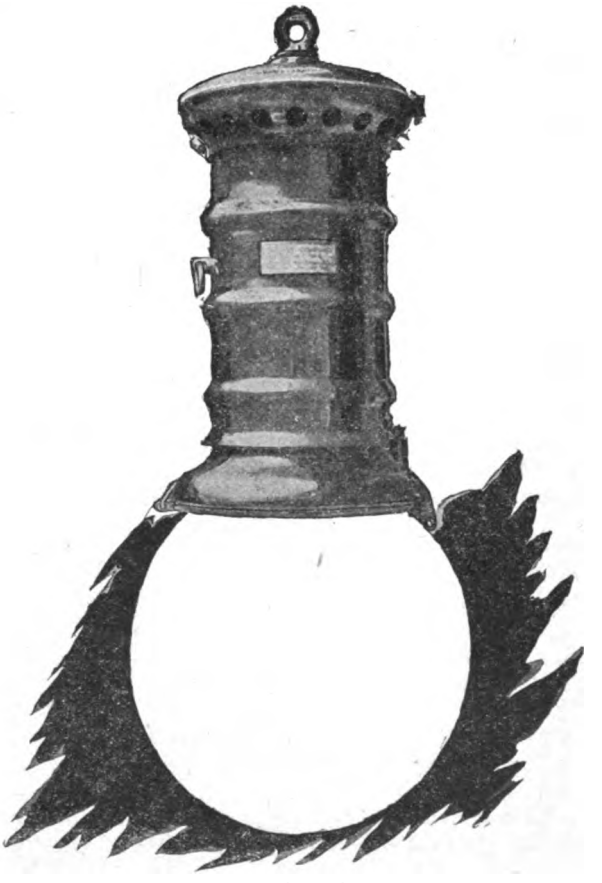


Fig. V.



Mechanism Exposed.



Lamp Complete.

By this device the pull on the armature is made uniform throughout its travel, and there is no need of a complicated system of weights or springs, which successively come into play to balance a variable pull. The electrical connections of the lamp will be understood by consulting Fig. 4. When the lamp starts, there are across the terminals three paths, and two that are important. One is a resistance of about one ohm shown at R. This resistance performs an important office that will be presently considered. The second path is through the carbons, which are together, via the series

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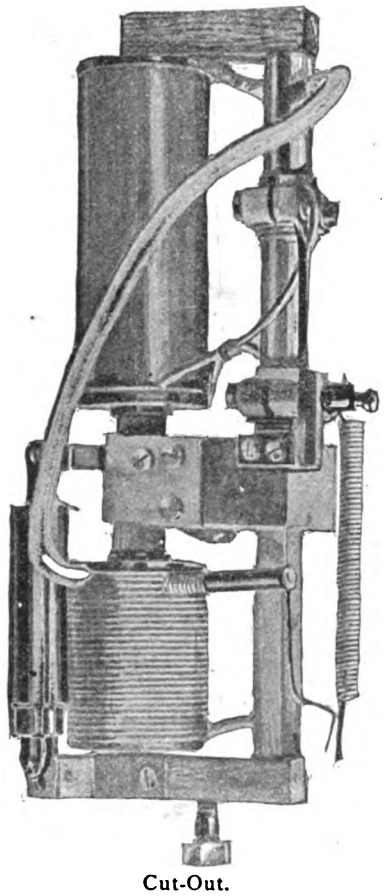
coil. The third is the shunt bobbin, but at the start the current in this part is too small to be considered. The resistance R is of such proportion that enough current passes through the series coil to start the lamp the moment the armature moves, and when the carbons are drawn apart R is cut out by a special cut-out, which is diagrammatically shown in the figure. The voltage of the lamp rises to its normal value. The shunt coil takes hold and regulates and feeds the lamp in the ordinary way.

Cut-Outs.—There are two distinct automatic cut-outs in the Walker lamp which act under different circumstances. They are both mechanical and one is operated by the same mechanism that operates the carbons and the other by the upper carriage which supports the upper carbon.

The latter, which is in the base of the lamp, dead

Convenient Features.—These appeal to the trimmer and user, and are numerous and unique. Both the carbons are clamped at one end with a universal joint, and are made to nose together with two centring rings, which are as near the arc as is practicable. The upper centring ring consists of a bushing in the base of the case. The upper carbon is contained in the case with the mechanism and feeds out through this bushing. The globe is readily lowered for trimming and is covered with a reflector plate, which performs the double service of arresting the sparks and reflecting the light downward. The carbon dust can be brushed in the dust-cap below, which can then be removed and emptied. These features are well illustrated in Figs. 3 and 5. It is important to note that no part of the lamp frame is alive, as is common with so many lamps, and which a number of fatal accidents have proved a dangerous practice.



Cut-Out.

short-circuits the lamp when the carbons are burned out, and as stated above is actuated by the weight of the positive carbon carriage, which descends directly upon it. This cut-out is also moved by a lever from the outside when it is desirable to cut out the lamp for trimming or any other purpose.

The other cut-out has the same functions that the ordinary cut-out in a series arc lamp always has, namely, to provide a shunt circuit for the current in case the carbons stick and fail to feed, or in case either carbon should be broken, or through some accident should become unduly separated.

It also provides a path for the current when the carbons are consumed, if for any reason the cut-out in the base of the lamp fails to act.

The resistance which is inserted between the positive terminal and this cut-out is for the purpose of shunting sufficient current through the series coil and carbons to start the lamp, and is common to all differential series arc lamps. In the Walker lamp this resistance is made of especially high resistance wire, having a resistance approximately three times that of German silver, and also having mechanical properties which are such that it can be heated to redness without affecting it in any way.

The arc, as before stated, is practically stationary, and the heat on the globe is therefore uniform and not liable to crack it as is the case with the travelling arc. The photographic views accompanying this circular, when consulted in connection with this description, cannot fail to give a comprehensive idea of the lamp, and if the party is interested enough to give a trial order, he need read no further literature to be convinced of its sterling qualities.

THE 121ST MEETING OF THE INSTITUTE, which was held at 12 West 31st street, New York, Jan. 26th, was devoted to the discussion of the question of standardizing generators, motors and transformers. The discussion was opened by Mr. E. W. Rice, Jr., and was participated in by Messrs. Lozier, Kennelly, Wolcott, Hutchinson, Lieb, Dunn, Coho, Pattison, Henshaw, Steinnetz, Mailloux, Osterberg, Mosscrop.

The appointment of a committee to consider the question was suggested and subsequently the whole matter was referred to council for such action as it may deem proper.

At the meeting of council in the afternoon the following associate members were elected:

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Chas. R. Bangs, special agent, American Telephone and Telegraph Co., 15 Dey street, New York.

M. C. Beebe, assistant in electrical engineering, University of Wisconsin; residence, 271 Langdon street, Madison, Wis.

Hugh Thomas Brown, superintendent electrical department, Selma Gas and Electric Co., Selma, Ala.

Edward P. Burch, electrical engineer, Twin City Rapid Transit Co., 517 6th avenue, S. E. Minneapolis, Minn.

Eben Clinch Crocker, electrical engineer, American Ordnance Co., 29 Harriet street, Bridgeport, Conn.

Albert B. Elias, electrician, Davis Coal & Coke Co., Thomas, West Va.

Chauncey Graham Hellick, electrical engineer, The Chicago Telephone Co., residence, 193 Dearborn avenue, Chicago, Ill.

Jacque L. Morgan, electrical inspector, Kansas City Fire Department; residence, 1702 Locust street, Kansas City, Mo.

Herman A. Prosser, electrician, Baltimore Copper Smelting & Refining Co., Keyser Building; residence, 1222 Madison avenue, Baltimore, Md.

John Joseph Swann, assistant editor, Engineering News, 220 Broadway; residence, 347 West 34th street, New York.

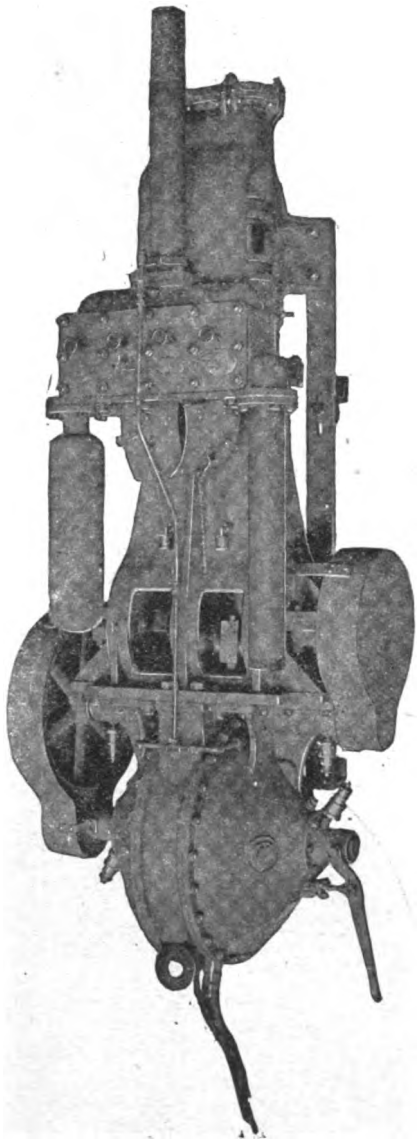
C. Walton Swoope, instructor, electrical engineering, Spring Garden Institute; residence, 12 North 38th street, Philadelphia, Pa.

Jin Tachihara, General Electric Co.; residence, 106 Union street, Schenectady, N. Y.

AN ELECTRIC MINE-SINKING PUMP.

A mine-sinking pump, light in weight, compact in form, of good capacity and efficiency, and not easily damaged by moisture or hard usage, has recently been constructed by the General Electric Company. A special form of motor is used completely enclosed with its gear and operating mechanism in a water-tight steel casing.

The pump itself is a 5 in. x 6 in. duplex double-acting Knowles pump, with outside packed plungers. It runs at 75 revolutions per minute and has a capacity of 150 gallons against 300 ft. head. It is driven by a 15 h.-p. induction motor, absolutely water-tight, with the shaft and starting lever arranged to pass through stuffing boxes. The casing was tested for leakage with steam pressure up to 35 lbs. per square inch. The wearing parts are all large and of extra heavy design, the crank shafting being one solid forging fitted with brass bearings. The connectiug rods are of the marine end type and are forged. The guides are bored in the intermediate mechanism so that the cross-head must always be in line with the pump cylinders. By removing one plate on the pump, all the valves may be reached at one time.



G. E. Mine Sinking Pump.

This apparatus was designed to stand without injury all the hard usage that a sinking pump can be subjected to. As the case is water tight, the pump works as well under water as out. It may be completely "drowned" by a sudden inrush of water in the mine, and its operation not be affected. This pump is now in operation at Pachuca, Mexico.

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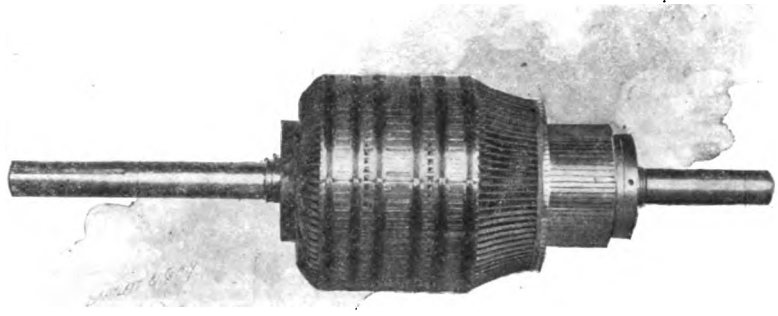
HIGH GRADE MULTIPOLAR GENERATORS.

The relation existing between a single cylinder and quadruple expansion engine is the same as that existing between a bipolar and multipolar dynamo. In the first case, crank bearings and shaft are used for one cylinder and piston. In the second case, the same parts are used in connection with two, three or more cylinders and pistons. A multipolar dynamo is therefore merely a succession of bipolar machines, having a common armature, commutator, shaft and bearing. The requirements of a good bipolar machine are merely accentuated in a multipolar machine. All that makes a bipolar machine unworthy of the market likewise affects a machine of the multipolar type. Dynamos built by the Excelsior Electric Company, of 115 Broadway, New York City, designed by Mr. Churchward, represent the full realization of the proper principles of design.

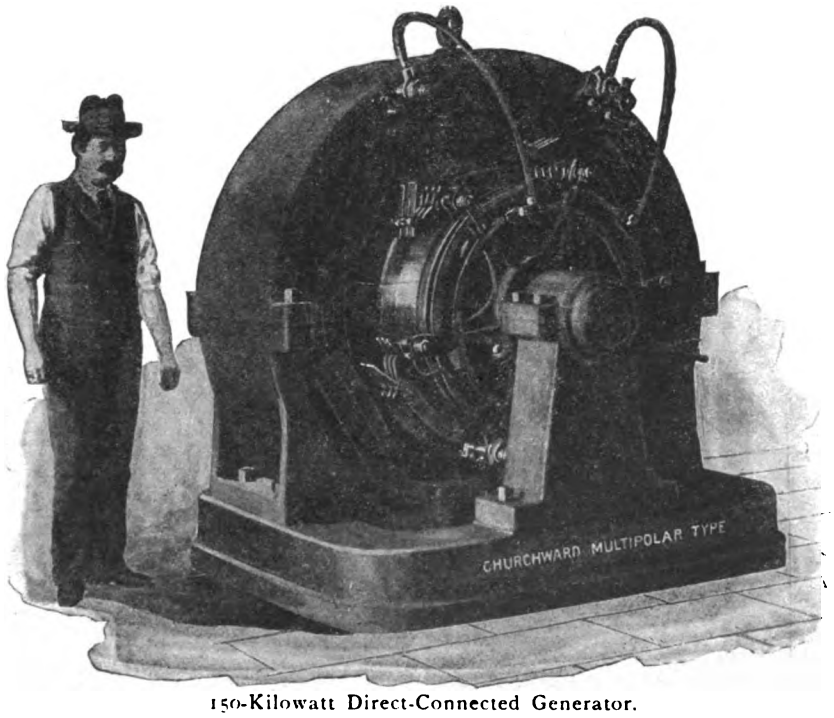


Belt-Driven Armature, 2½ to 65 Kilowatts.

In the illustration is represented one of the Excelsior Electric Company's generators. The fields and armature run very cool, the C^2R loss being at a minimum. The permeability of the magnetic circuit is very high, thus calling for but little magneto-motive force to produce a strong field. The depth of winding, size of wire and radiating surface are such that the machine will not heat, Whereas the principle that iron is cheaper than copper has been observed, a noteworthy feature of the machine is the presence of plenty of copper in the commutator and armature; the excellent mechanical design insures smooth running and no loss through friction of bearings. The additional illustration of the armature of a bipolar machine shows the excellent workmanship and careful attention this important part of the dynamo receives.

The office of the company is in charge of officials who will be glad of the opportunity of showing prospective purchasers methods of manufacture, quality of material and the size of some of the plants the company have installed. Excelsior apparatus is gaining ground every day and can be highly recommended by all using it.

Mason, Mich.—The Lansing, Dexter & Ann Arbor Electric Road will be constructed.



150-Kilowatt Direct-Connected Generator.

UNITED STATES ELECTRIC PLANTS FOR MALAGA.

Under date of January 9 Consul Bartleman, of Malaga, transmits a newspaper extract which states that two companies have sprung into existence there to supply the demand for electric lighting in Malaga. "With a population of about 125,000 inhabiting some 20,000 to 25,000 houses or flats," adds the article, "it is evident that there is ample room for two works. One company is of German and the other of English foundation, identically

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The Electrical Age.

ESTABLISHED 1888.

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NEWTON HARRISON, E. E., Sec'y, Treas. and Editor.

ADDRESS ALL COMMUNICATIONS TO
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THE THOFERN SYSTEM OF REFINING COPPER.

The art of refining metals has been developed in the last twenty years through the application of electricity and the broader experience possessed by the superintendents of electrolytic plants. The great mining regions of the West have become rich fields for enterprising men and paying sources of investment to capitalists since the old mining methods have been abolished and the newer, cheaper and dividend paying system of electrolytic refining taken its place. The production of pure copper is of the greatest consequence to the electrical profession and it is a marvellous coincidence that the best method of purifying it should be found in the employment of those scientific principles upon which its use mainly depends. The Thofern system of refining copper is now used by the Anaconda Copper Company in place of the Hayden series process. About one hundred and fifty tons of refined copper per diem represents the output of the Anaconda mining plant by this new system. Its economy and success go hand in hand and are of so pronounced a nature that it will probably become as generally employed as the Bessemer process for the refining of steel or any other well known process.

The plant at present installed consists of four 270 K. W. Westinghouse generators, direct-connected to two triple expansion engines of 900 horse-power each, in addition to which is another large Westinghouse generator, belt-driven by a double Corliss 800 horse-power engine, In this gigantic plant a reserve 220 K. W. generator is held, to be belt-driven when required by a 400 horse-power compound engine. The battery of boilers evaporates 62,200 pounds of water per hour. Two triple expansion engines use 23, 160 pounds while generating 1080 watts in the dynamos.

The above mentioned Corliss utilizes 22,500 pounds of water per hour in producing 490 K. W. 1500 pounds of steam are consumed each hour in the operation of the electric light and power plant and about 900 pounds for the operation of the acid pumps. With this grand total a hundred and fifty tons of copper are produced from the refining vats every twenty-four hours. The cost of production, which includes every expense attendant upon the handling of the copper, the making of the cathodes, working the silver mill and running electric lights, reaches about 17½ horse-power hours per ton, which on a dollar and cent basis, would rate the cost of production. Wooden tanks are used in the electrolyzing process, each tank eight feet three inches long; four feet seven inches wide; three feet, three inches deep. Ten vats are placed, end to end, in a row, each row built on an inclined plane, the electrolyte passing from one to the other.

The blister copper, used as an anode, carries the following materials: 98 per cent. of copper, 110 ounces of silver, ⅓ of an ounce of gold per ton in combination with such impurities as arsenic, antimony, iron, lead, tellurium and selenium. In each tank the slimes or silver mud is taken to and treated in the silver refinery. Laboring under present expenses, which represents a payment of $3.00 per day per man and $5.50 per ton for fuel, each ton of refined copper costs $14.00.

In Thofern's process, from ten to twenty amperes per square foot are used. The copper wire produced from this quality of metal has about 98 per cent. of the maximum conductivity. The object of going into the details of this great system is two-fold; first, because the application of electricity to the processes of refining are so valuable that commercially they cannot be replaced. Second, a close study of the methods employed will give the scientific and practical mind an opportunity of so economizing in the employment of electricity that a greater output is possible under improved conditions with a given amount of power than before.

From either standpoint the natural result is a great diminution in the cost of production, a greater out-put of copper, a lower price, and in total a greater stimulus to the arts and allied industries, which co-ordinate in its production.

UNITED STATES STUDENTS IN FRENCH SCHOOLS.

General Horace Porter, United States ambassador to France, writes from Paris under date of January 11, 1898, in answer to an inquiry in regard to the admission of a student from the United States into the School of Mines. No foreign student, he says, can enter any of the schools of France — medicine, pharmacy, dentistry, veterinary, painting, design, architecture, music, declamation, engineering, etc. — without the formal application of the diplomatic representative of his country. In most cases two letters suffice, one making application, the other expressing thanks when the request is granted. Sometimes more correspondence is necessary, for the reason that those proposing to enter any of the high-grade schools have to produce certain certificates of studies, or diplomas, which the authorities accept only when they come through the embassy. These rules, says General Porter, apply to all foreign students. No discrimination is made against Americans; on the contrary, the authorities extend all possible facilities to them. There is a large number of American students in Paris, and, as a rule, they are much liked by the teachers in French institutions.

As for the School of Mines, he continues, foreigners can be admitted there either as foreeign pupils, in which case they have to stand an examination, or as free auditors, in which case there is no examination. All the courses, however, are not open to that class of students, and no diploma is granted them. In both cases they have to pay 50 francs ($9.65) for matriculation. If the school is full, as occasionally happens, the application for admission is put off until the next year.

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as is the case in Madrid, where the two rival companies, working each on the same tariff, have so satisfactorily divided the business that they both made a profit of over £30,000 last year. Our concern at the moment, however, is not with the German but with the English works.

"In one respect, the Malaga company gives a lesson to its English confreres, for it has adopted the principle of free wiring, with the result that it starts with a paying load at once, and has thereby placed itself in the position of being able to earn a dividend in its first year, instead of having to spend two or three years in pioneering, as in the case of almost every English concern.

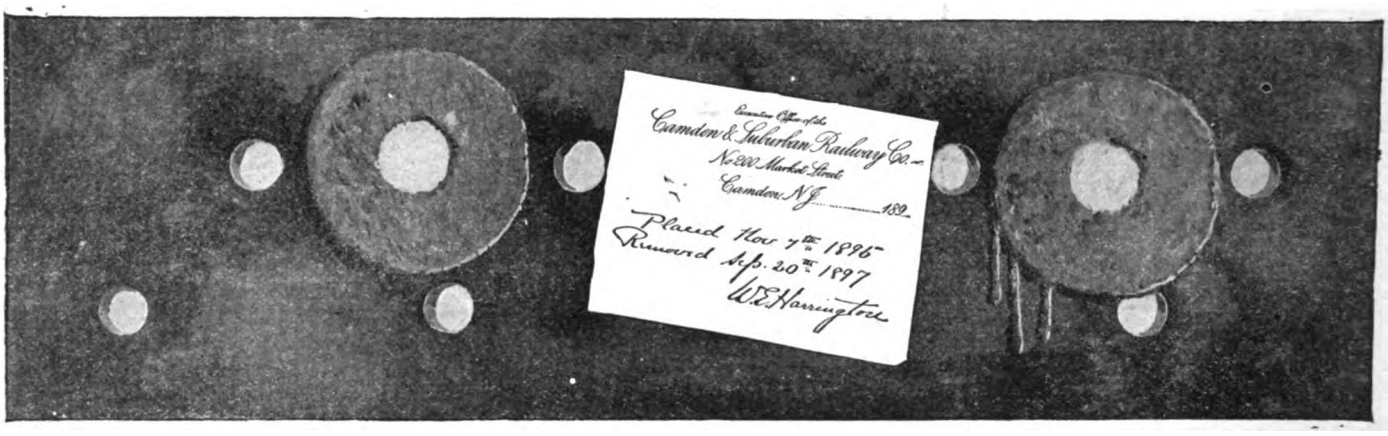
"The capacity of the plant at present in operation is 330 kilowatts, and Messrs. Fowler & Co. still have in hand under their contract another set similar to those in use; but the completion of this has been seriously delayed by the strike in the engineering trades. The great demand for electricity, however, has rendered essential the erection of further generating plant, and, as the engineering strike in England has prevented the completion of English-made machines, the directors have had to place their orders in other quarters. They have arranged with the Westinghouse Electric Company, of Pittsburg, to supply immediately two sets of plants, each of 135-kilowatts capacity, and these are now on their way to Malaga and will be erected early in the new year. The total capacity will thus be raised to 765 kilowatts, and, in addition to this, we understand that the directors have under consideration the consulting engineer's estimates for two further sets of plant, each of which is to be of 300 kilowatts capacity.

"From this it is very evident that the business in Malaga is making rapid strides, and that the undertaking will develop into a highly profitable enterprise. Of this we can have no doubt; and, if we had, it would be dispelled by the intelligence to hand from Malaga that up to the end of November last, after the works had been in operation for less than two months, upwards of 800 consumers had applied for a supply of electricity, and that 7,200 lamps were then connected to the mains. On the day when the supply was started, the maximum load was 16 kilowatts and the output for the day only 29 units, but by November 30, the load had reached 128 kilowatts and the output for the day had advanced to 884 units, while on December 11, 148 kilowatts was recorded as the highest load and 1,093 units as the day's output.

THE EDISON PLASTIC RAIL BOND.

Modern practice in rail-bonding for electric traction calls for a generous amount of copper, with a rail contact area seven to ten times its cross-section, and with heavy bolts, nuts or wedges to hold the two metals together. When such a joint is covered with a viscous paint it would seem to be mechanically and electrically perfect; but careful measurements of the drop in these joints, even when new and at their best, give startling results with heavy currents. The thermo-electric difference between steel and copper evidently causes a loss many times that due to the resistance of the copper alone. But when this joint has been submitted for even a few months to the acidulous moisture of a city street, and to the mechanical changes encountered in service, the loss grows rapidly greater. Only a short time is required to deposit a slight film of iron rust between the surfaces of rail and bond; this film is of high resistance, and serves as a channel for the admission of more and more moisture, and conductivity decreases rapidly. Every passing car and each change in current aids in the work of destruction.

Since the spring of 1889 experiments have been in progress at the Edison laboratory, with its magnificent equipment for investigation, in order to obtain a rail bond of permanently low resistance, which would make an absolute electrical union and would be proof against rust and against mechanical injury from the hammering of wheels, the changes of temperature and variations of current. Hundreds of promising schemes were tried and found wanting. Every practical combination of metals, every method of joining, of excluding moisture, of providing for expansion and contraction, has been tested with heavy currents and then buried for the test of time. The contact surfaces have been welded together, have been machined and scraped to an exact fit, bolted together with heavy pressure, plated with tin, nickel or copper, provided with sheet lead, tin-foil or other soft metal, or with various non-rusting alloys placed under insulation, or a combination of several of these. Only a single one of these has successfully withstood the test of time and has proved to be a satisfactory rail bond. After a test of about five years on buried rails, it showed no increase of resistance, carrying 1,500 amperes with a loss of but $\frac{1}{16}$ of a volt. A large number of these joints were dug up for examination, and showed no trace of rust on the contact surfaces. This long experience resulted in the invention of the Plastic Rail Bond, which has been in actual service for the past three years.



Edison Plastic Rail Bond.

For this bond, no holes in the rail are needed, nor any wires, plates, bolts, nuts or rods, and the completed joint is perfectly protected by the fish-plate. The plastic bond is composed of two portions; a plastic or putty-like metal compound which makes contact between the rail and the metal of the joint, and a flexible elastic cork case to hold same in position, as near the end of the rail as possible.

The current passes from one rail through the bond to the angle plate, and then through the second bond from the plate to the next rail. In putting this bond in place, contact spots about two inches in diameter on both rails

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and plates are cleared of scale and rust, and the centre of each of these surfaces is rubbed with a special alloy, discovered by Mr. Edison, which instantly changes any iron rust to pure metallic iron, and forms a silver-like deposit which repels water and will not corrode. A permanent iron amalgam, which has been considered a chemical impossibility, is thus produced upon the surfaces, and in this lies the cause of the low resistance and durability of the bond.

One side of the case is then placed upon the prepared surface of the web of the rail and a plug of the plastic metal surrounded by an amalgamated steel spring washer is put into the hole. A second case and plug is then similarly placed on the adjoining rail, and the fish-plate is bolted down. The tightening of the bolts compresses the cork to half its former thickness, and makes its surfaces stick firmly to the steel, the spring forming a distance piece to prevent too much compression. The fish-plate nuts are locked in position, but even if they should slacken and the plate drop back even one-quarter of an inch, the cork will expand or be pulled out to its former thickness by the adhesion of the insulating compound to the steel, and the plastic metal, by gravity and the expansion of the spring, will maintain a perfect electrical contact.

In fact it is hardly accurate to call this junction a contact; "union" is a better word, since the adhesion is so great between the prepared surfaces of the steel and the metal of the bond that its conductivity is equal to that of the rail itself. The plastic metal cannot be injured by the blows of passing wheels It is sealed from air and water, and remains plastic indefinitely, if properly applied. The elasticity of the cork permits the movements of rail and fish-plate due to expansion and contraction, produced by changes in temperature. Even though water or any acid or alkali likely to be encountered in the streets should get to the plastic metal, it cannot affect it nor corrode under the prepared surface of the steel, into which the amalgam seems to penetrate.

The remarkable conductivity of the joint and its low drop has been demonstrated by tests after two or three years' use in the United States, South America, Australia, and England. As this bond has a conductivity equal to the rail itself, a large reduction in feeder wire can be made by its use.

It is cheaper than a copper bond of half its carrying capacity, and will last as long as the fish-plate. It is evident that no road using bonds of copper wires can be overated with the greatest economy of power, as the loss in transmission with copper is from seven to ten times greater than the loss with the plastic bond.

Chestertown, Md.—W. J. Hoffman and J. K. Wright have been granted franchise to light the town, and will erect a $15,000 electric plant.

Bay City, Mich.—The Bay, Tuscola and Huron Electric Railway Company has been formed to construct an electric road from this city to Sebewaing.

TELEGRAPHING WITH AND WITHOUT WIRES.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

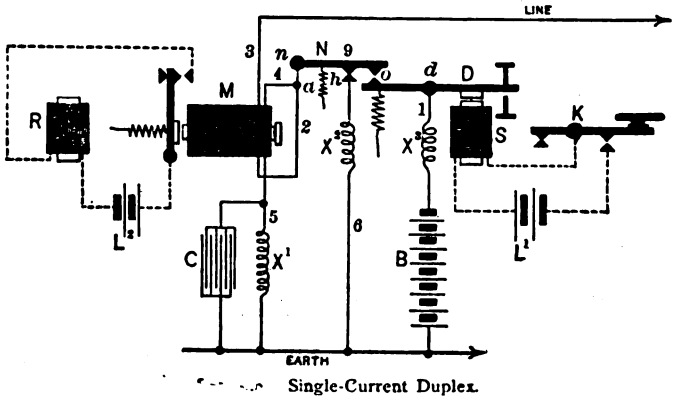
BY NEWTON HARRISON, E. E.

The art of transmitting signals is of recent growth, but the history of earlier attempts dates back to at least a century ago.

When the fact became known that bodies could be arranged into two general classes—conductors and non-conductors—the transmission of signals electrically to distant points became a possibility.

At present the Western Union Telegraph Company possesses 600,000 miles of wire and sends annually about 50,000,000 messages.

This is the result of one man's work, S. F. B. Morse, who was impressed with the importance of a telegraph system, and through whose earnest efforts we are able today to sit in our homes and send messages thousands of miles away with inconceivable quickness and dispatch.



Single-Current Duplex.

The labors of Henry in practically inventing the electro-magnet made Morse's work a simpler matter than had been expected. It is even believed that an electric telegraph was invented by him, consisting of an electric bell actuated by a key. This was in the year 1831. But it seems to the reflective mind that perhaps the greater discovery of all was the invention of the electro-magnet, irrespective of its innumerable applications. It is in all reality the breath of life to electrical mechanism, such as motors, all signalling devices and a host of other important pieces of laboratory apparatus.

We can look back to a period prior to either Morse or Henry's and meet with Oersted, whose notice of the reaction between a compass needle and a current-carrying coil sent a wave of discussion through the scientific world.

Sturgeon subsequently built an electro-magnet whose core was of soft iron, in place of the steel previously used.

Henry constructed a powerful electro-magnet capable of holding 2,000 pounds in suspense, which is in existence today.

The genius of Morse lay in the thorough appreciation of the value of a telegraphic instrument for direct use, the same in his time being practically an electro-magnet with a stylus or point cutting or marking the band of paper automatically fed beneath it, the point being actuated by an armature controlled by an electro-magnet and a keg at some distant point.

The telegraph systems of today are about reducible to one—the Morse system.

Wheatstone, of England, Elisha Grey and others produced printing and needle telegraphs, but none other than the printing telegraph besides the Morse has survived. The Morse outfit in its simple form consists of

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Key,
Sounder,
Line,

and a set of cells to operate the same.

The key consists of a simple switch, the part pressed by the hand making contact with a point below, but springing back when pressure is released. The spring or lever portion connects with one wire and the point below with the other wire of the circuit.

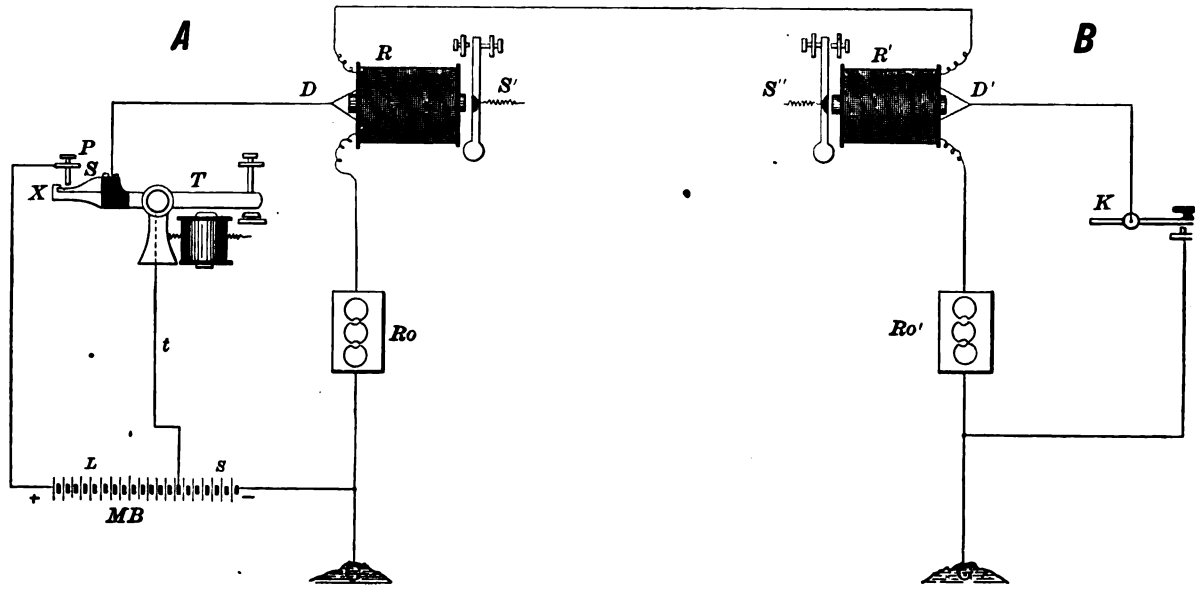
The sounder—whose original form was that of an elec

with for long-distance work, leaving the modern sounder in its place.

The great genius of Morse lay in his ability at that period to place before the public an instrument whose simplicity was an absolute guarantee of its success.

The line was supported then, as now, upon poles with insulators. The first line connected with Washington and was only erected after a donation from Congress had been received. Its success was heralded all over the world as an achievement which at once elevated mankind

PLATE XV.



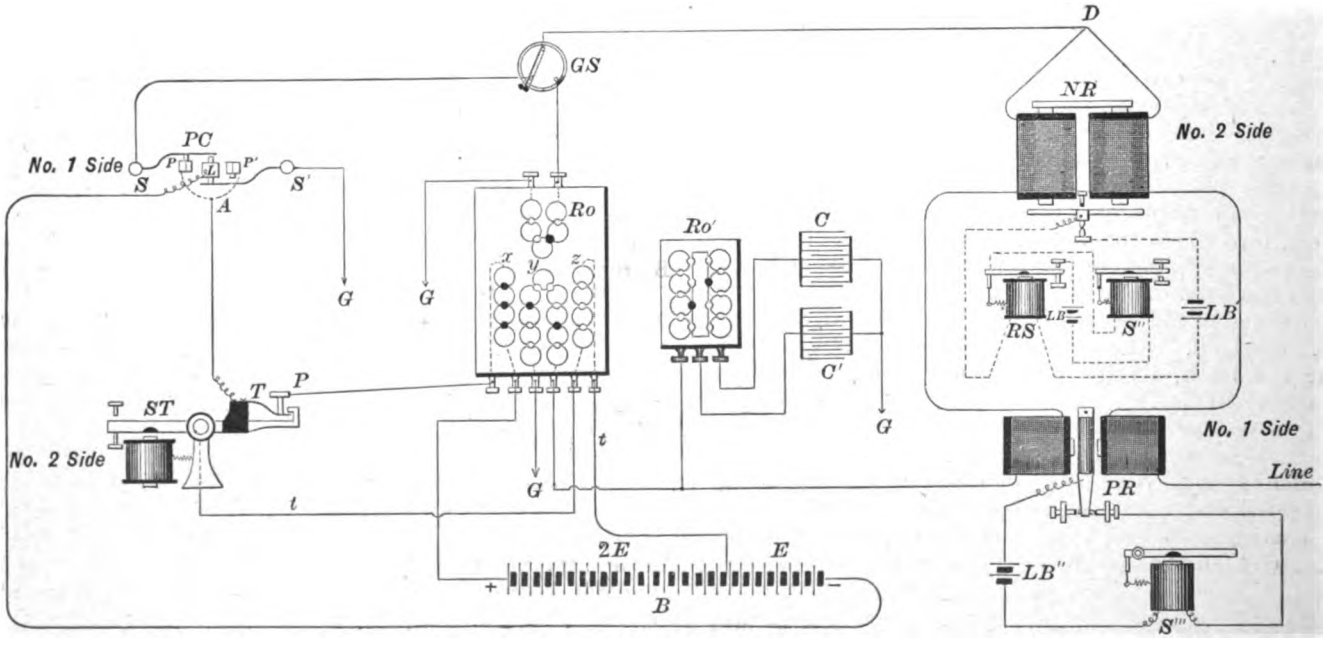
STEARNS' DUPLEX WITH BATTERY AT ONE STATION ONLY.

tro-magnet which moved an armature, connected to which by an arm was a marking or cutting point making a series of dashes upon a paper strip—has been replaced by the original electro-magnet and lever with armature at the end. It was eventually noticed that the click of the older form of apparatus was capable of imparting a

immeasurably above the plane of life he had been living in for untold ages.

Since Morse constructed the first simple, single-message telegraph, other inventors have improved upon it by the addition of mechanism for sending two, four or more messages over the single connecting wire at the same

PLATE XVII.



THE QUADRUPLEX.

MATTHEWS, NORTHRUP & CO., ENGRS. & PRS., BUFFALO, N. Y.

signal as well as the mark. Telegraphers became so experienced that the audible click was all they required to frame their sentences. The tape was then dispensed

time.

A two-message system is called a duplex, if coming from opposite ends; from the same end, a diplex mes-

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sage. A double diplex or double duplex constitutes the quadruplex. A system covering more than a single message at a time might justly be called a multiplex system, but is usually called such only when the number exceeds four at a time.

Part II.—Multiple Telegraphy.

It is a matter of considerable difficulty to describe within a limited space the principles of multiple telegraphy; yet by careful analysis it is possible to reduce the subject down to a few simple principles.

Single Message System.—A simple circuit, including within its limits a key, sounder and battery, offers no difficulties to the understanding. The line may be a double metallic circuit or it may consist of an overhead line with an earth return. To secure an earth or ground return, the extreme ends of the line are twisted around a gas or water-pipe respectively, or attached to a metal plate sunk into moist earth and involved in a bed of coke, charcoal or scrap metal. But one message can be transmitted through a circuit of this description, and over but a limited length of line, if no accessories are added. The longer the line the greater the battery power required to compensate for the leakage occurring throughout its length. It is impossible to send a current many miles without great loss; it therefore becomes neessary to employ a device called a relay to remedy this difficulty.

Relay.—A relay consists of an electromagnet whose armature, when attached to the poles of the electromagnet, closes a switch; that is, brings two contact-points together, which open and close a small circuit containing a series of cells and the sounder. The original current coming over the line operates this relay, which a very weak current will actuate. At the end of a long line a relay will prove a most serviceable piece of apparatus, because the current it takes would never be sufficient to work a sounder distinctly, yet proves enough to move the armature of the relay a trifle, thus closing the independent, local circuit in which the sounder and new cells are placed. The sounder, by this means, gives a most emphatic signal, perfectly audible and satisfactory.

Importance of the Relay.—The entire practice of duplex and quadruplex telegraphy depends to a great extent upon the relay, modified, of course, to suit either, but still retaining its position and performing its functions as described.

Kinds of Relays.—There are several kinds of relays known under the names of

Neutral relays,
Polarized relays,

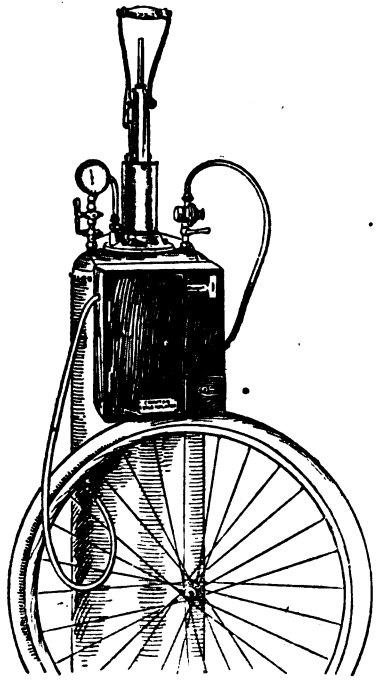
each of which may be wound with a form of winding that is called differential winding.

(To be continued.)

"A PENNY DOES IT."

The Compton Automatic Cycle Inflator—The Latest Boon to Wheelmen.

A penny-in-the-slot machine for inflating tires is the one thing wheelmen need. Mr. Compton, the inventor of the automatic cycle inflator, seems to have hit the bull's-eye. The inflator does the whole business. All that is necessary is to attach the flexible tube to the valve on cycle tire, drop a penny in the slot and in a few seconds your tire is hard. There is no lever or pump.



Automatic Cycle Inflator.

handle to work, nothing in fact to do but simply produce the price, one cent, and the machine does the rest. The machine will be found along all the streets, avenues and roads traversed by wheelmen the coming season. A regulation sign will be displayed wherever one of the machines is located so that wheelmen, as they ride along the street are informed "where they are at." Mr. Sydney B. Bowman has leased a thousand for Greater New York; Charles S. Smith & Co. have leased five hundred for Philadelphia, and leading cycle dealers are hustling to get control of the machines in their respective cities. No one will think of using a pump after they have once tried this automatic inflator. Pennies instead of pumps will be carried by wheelmen in the future for "a penny does it."

Mr. Melvin B. Compton, the inventor of the cycle inflator and president of the company, is one of the most ingenious and successful inventors of the present time, having invented the automatic electrical control and Compton's magnet thermostat system, which has been so successfully introduced throughout the country for automatically controlling the temperature in large buildings, theatres and especially private residences, now owned and being introduced by the Compton Automatic Control Company, Times Building, New York, and 114 N. Broad st., Philadelphia, Pa. Another of Mr. Compton's successes is the Compton Electrical Bulletin Company, of 112 N. Broad

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street, Philadelphia, whose electric system reproduced the baseball games to crowded houses at Music Hall, Boston, last summer.

DEATH OF WM. HABIRSHAW.

Wm. Habirshaw, only son of Mr. W. M. Habirshaw, of the India Rubber and Gutta Percha Insulating Company, died of pneumonia at Yonkers, N. Y., on Sunday, of this week. He was a young man of great promise, and had been an assistant to his father in the manufacture of Habirshaw wires and cables.

SIEMENS & HALSKE ELECTRIC COMPANY.

The New England representative of the Siemens & Halske Electric Company of America, N. E. office, 178 Devonshire street, Boston, have just obtained the contract for the new Municipal Lighting Plant at South Norwalk, Conn. This plant will be of interest to the engineering fraternity generally, as it is to be run on the straight 220-volt two-wire system for arc and incandescent lights as well as power. While a large number of these stations have been put in abroad there have been comparatively few installations of the kind here, except for isolated plants.

The New England business of the Siemens & Halske Company has been very satisfactorily increased during the past year—one of the most notable contracts being for the Boston City Hospital.

Another plant is being installed in the new theatre at Springfield, Mass., of two 75-k.w. machines running at 100 r.p.m.

Still another theatre plant has been running for several months at the Academy of Music, Fall River, Mass., while one of the largest orders secured, and now in satisfactory operation, is that for a large manufacturing plant, in which motors ranging from 10 to 100 H. P. in capacity, (aggregating a total of about 1,000 H. P. full-load capacity) with 100 Manhattan lamps and several hundred incandescents, are operated from a single set of bus-bars at 220 volts, current being furnished by two machines of 400-k.w. capacity each, with a smaller one for night service.

The generators in all the above-mentioned plants are of the Standard Siemens & Halske external armature type, while a large number of internal armature belted machines in both the slow and moderate speed types for generating and power service have been installed in Boston and vicinity during the past few months.

H. C. Spaulding acts in the capacity of special sales agent at the address given above.

MESSRS. CARRÈRE & HASTINGS beg to inform you that they have removed their offices to 28 East Forty-first street, Madison avenue.

HENRY ELECTRICAL SOCIETY.

Rooms, Nos. 111–115 West 38th street, New York.

January 26, 1898.

The 96th meeting of the Henry Electrical Society was held at Columbia University, Engineering Building, Room, No. 302, on Friday, February 4, 1898, at 8:15 P. M., at which A. H. Ford, E. E., delivered an experimenal lecture on "Transformers."

BEAUTIFUL WHITE MAHOGANY BOARD FINished in rich plush, all ready for exhibiting all kinds of goods; size 4 feet 6 x 7 feet 6 ins., will be sold low for cash at the office of H. P. Ball Manufacturing Co., 101 Beekman street, N. Y.

ELECTRICAL SHOW NEXT MAY AN EDUCATIONAL FACTOR.

An auxiliary and educational committee has been formed to take general charge of exhibition matters other than commercial, and to co-operate with the Advisory Committee which represents the New York Electrical Society. The Auxiliary Committee comprises men of the highest standing, all of whom intend to take an active part in the work and are now making extensive and interesting plans. Mr. T. C. Martin, who was chairman of the very successful committee of the 1896 show has again consented to serve in the same capacity. With him are associated Prof. F. B. Crocker, of Columbia University; Prof Morris Loeb, of the University of New York; Prof. W. E. Geyer, of the Stevens Institute of Technology; Dr. Chas. A. Doremus, of the College of the City of New York; Mr. Herbert Laws Webb, of the New York Telephone Co.; Mr. J. B. Taltavall, editor of the Telegraph Age; Dr. Park Benjamin; Secretary G. H. Guy, of the New York Electrical Society; Mr. W. T. Wheeler, vice-president and national deputy, National Association of Stationary Engineers; Lieut. G. O. Squier, U. S. A., and Mr. Thos. A. Edison, Jr. (who is in charge of some special decorative and mechanical effects).

It is believed that this committee, enjoying as it undoubtedly will the heartiest confidence and co-operation of all, will be able to accomplish some extremely useful and memorable work in behalf of the science of industry.

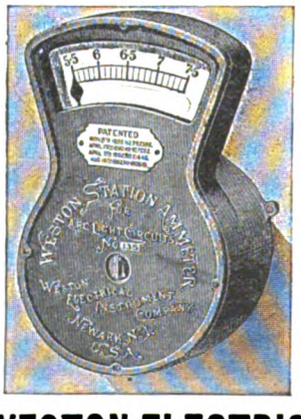
As already announced, the New York Electrical Society is the body under whose auspices the Exhibition is to be held, and it has appointed an Advisory Committee entrusted with its interests, and composed of its present officers and past presidents, namely, present officers, Dr. M. I. Pupin, president, and Messrs. Dunn, Sinclair, Case, Osterberg, Guy, Riker, Coho and Ker; and past presidents as follows: Messrs. F. W. Jones, Small, Pendleton, Crocker, Wetzler, Mailloux, J. W. Lieb, Jr., and Dr. C. E. Emery.

REMOVAL NOTICE.—We beg to announce to our friends and patrons that on and after February 1st, 1898, our office and factory will be found at No. 27 Rose street, New York City. DE VEAU & CO.

South Boston, Mass.—The Boston Electric Light Co. will erect a plant.

Johnstown, Pa.—The Lykens & Williams Valley Street Railway Company has been incorporated with John B. Skyles, president, to construct and operate an electric line between this place, Schuyler County, and Lykens, Dauphin County, a distance of 10 miles.

Spring Green, Wis.—G. S. Post may be addressed concerning construction of electric light plant.



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CHEAP, RELIABLE, AND VERY ACCURATE.

ABSOLUTELY "DEAD BEAT."

The scale is so proportioned that a change of 1-10 of one ampere can be seen from a considerable distance. Three different ranges:

No. 1—5.8 6.8 7.8 amperes in 1-10 ampere div.

No. 2—8.6 9.6 10.6 amperes in 1-10 ampere div.

No. 3—9.5 10.5 11.5 amperes in 1-10 ampere div.

Mention Electrical Age when writing for Catalogues.

WESTON ELECTRICAL INSTRUMENT CO.

114-120 William St., Newark, N. J., U. S. A.

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NEW X-RAY TUBE

With Automatic Vacuum Regulator.

No more Troubles from High Vacuum Tubes.

SIMPLE AND EFFICIENT.

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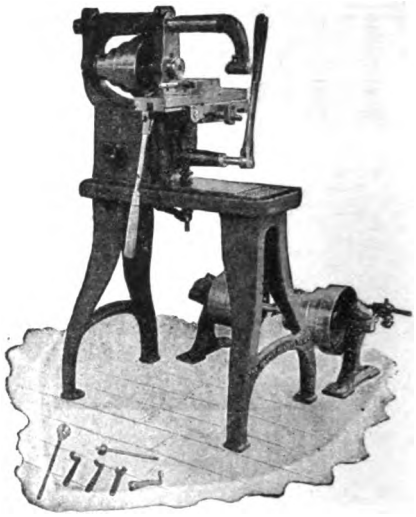

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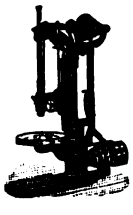

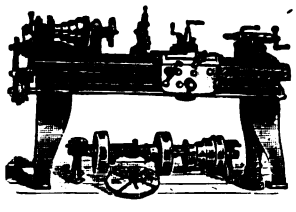

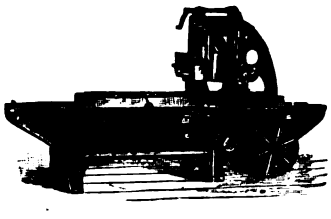

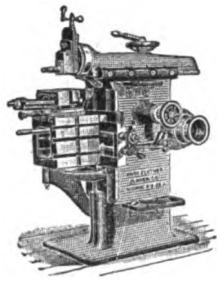

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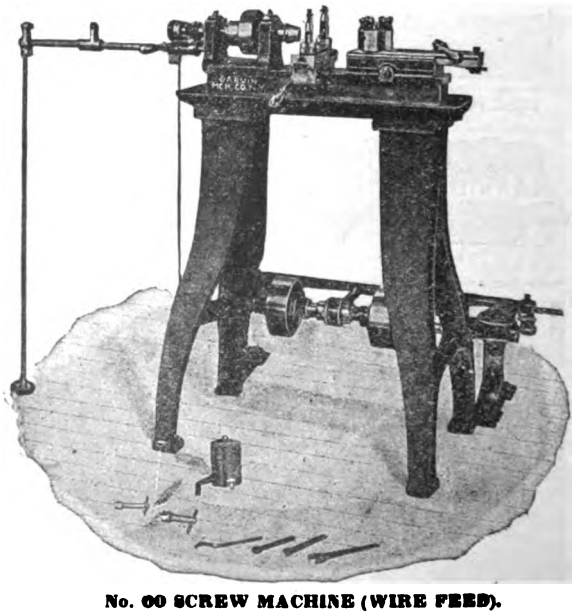

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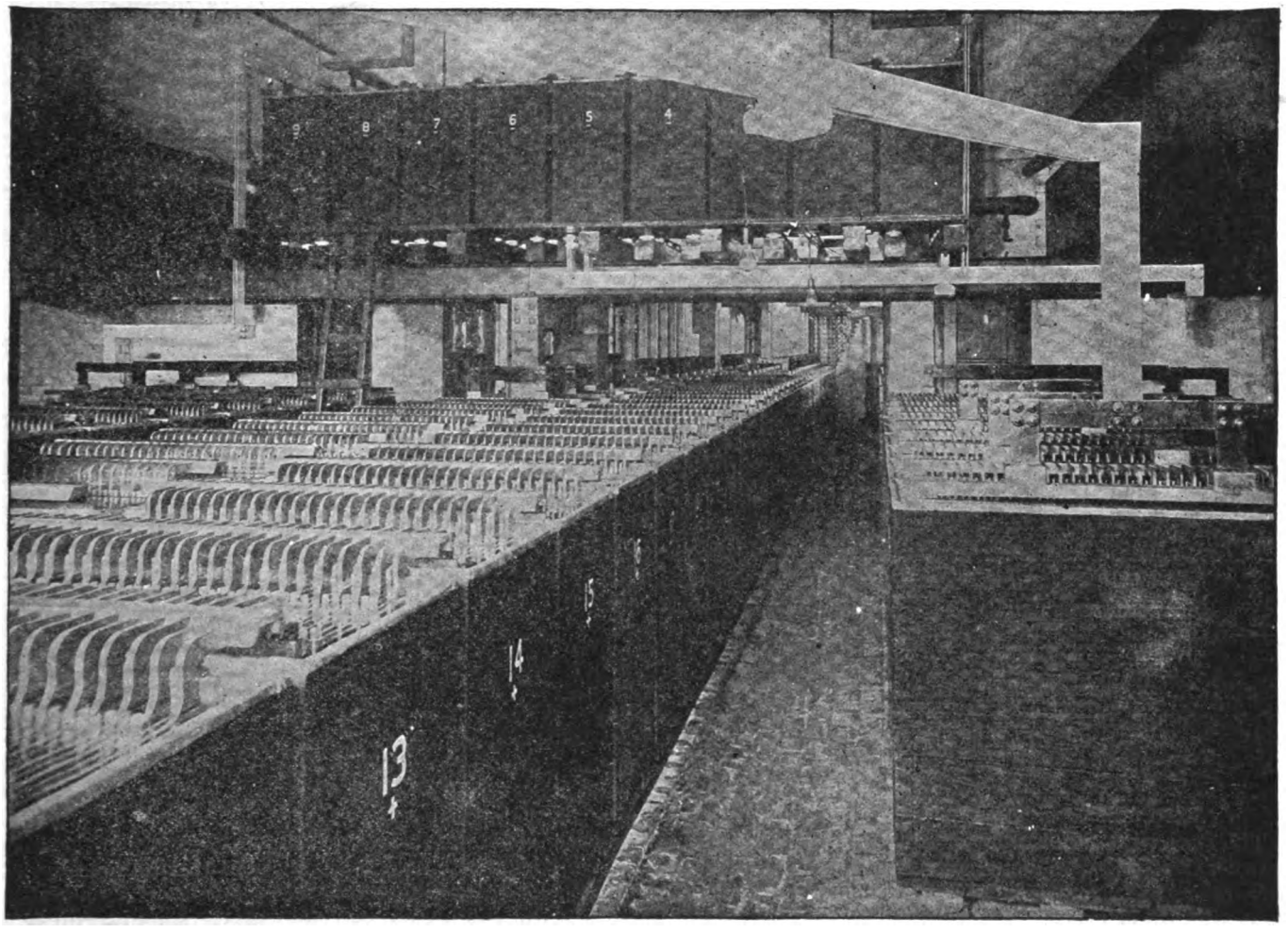
The Electrical Age.

VOL. XXI—No. 7 NEW YORK, FEBRUARY 12, 1898 WHOLE No. 561



Plant of the Edison Electric Illuminating Co., Philadelphia, Pa.

THE CHLORIDE ACCUMULATOR.

Electrical engineers have instinctively groped in the past for some means whereby storage batteries could be used with advantage to electric light plants. The time has now arrived, not only for proving that they have their function to perform in this profession, but that for years success in many directions has been hindered by their non-usage. The present chloride accumulator possesses advantages which appeal to the mind of every competent engineer with tremendous force.

The fact that the plates composing a chloride accumulator are mechanically strong, free from the familiar diseases so frequently afflicting other types, is encouraging to a high degree. Buckling is absent and plate deterioration cannot occur. The plugs are firmly attached to the foundation in which they rest and the capacity of the plate or cell can be called upon without risk to give up its stored energy, without the collapse frequently expected in many experimental types of storage batteries. For electric light work, the advantages derived from the use of accumulators are only too evident.

First, reduction in coal consumption and general operating expenses, due to the generating machinery being run at point of greatest economy while in service and being shut down entirely during hours of light load, the batteries supplying the whole of the current.

The possibility of obtaining good regulation in pressure during fluctuations in load, especially when the day load consists largely of elevators and similar disturbing elements.

To meet sudden demands which arise unexpectedly, as in the case of darkness, caused by storms or thunder showers; also in case of emergency due to accident or stoppage of generating plant.

Smaller gencrating plant required where the battery takes the peak of the load, which usually lasts only for a few hours, and yet, where no battery is used, necessitates sufficient generators, etc., being installed to provide for the maximum outfit, which in many cases is about double the normal output.

For this purpose, it has been demonstrated that the battery is a profitable investment, the cost being equal, or, in fact, less than the generating plant required to supply the maximum output; and when the other advantages are considered, there is no doubt whatever that the storage battery is an essential feature, both technically and commercially, in a central station plant. It is certain that as time rolls on other applications will be made of the storage battery, as it gradually diminishes in weight and increases in capacity. In the equipment of a central station provision is of course made for the normal load it is supposed to supply; but in such cases, where the load increases beyond the capacity of the plant, it is found cheaper to add an accumulator installation to carry the so-called peak than to provide an additional equipment of dynamos and engines which may be called upon only for a couple of hours each day and possibly not even pay the interest on the original cost of their installation. The storage battery equipments put in by the electric

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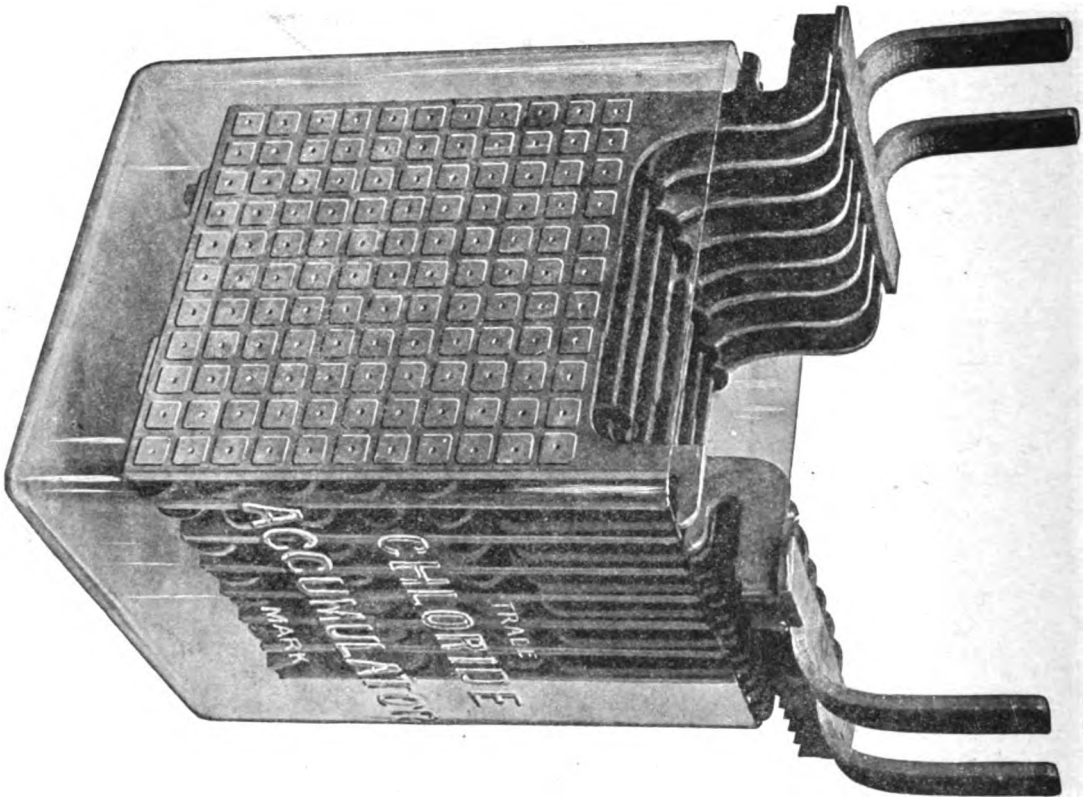
Storage Battery Company, of the Drexel Building, Philadelphia, are about the very best that the engineering profession can expect. The cells are strong, reliable and able to endure sudden changes of load, which would rapidly deteriorate all other types.

The advantages accruing to the public from this cannot be overestimated. For the first time in the history of electrical arts storage battery companies are in a position to furnish the individual types of batteries best adapted to special purposes. Not only that, but the

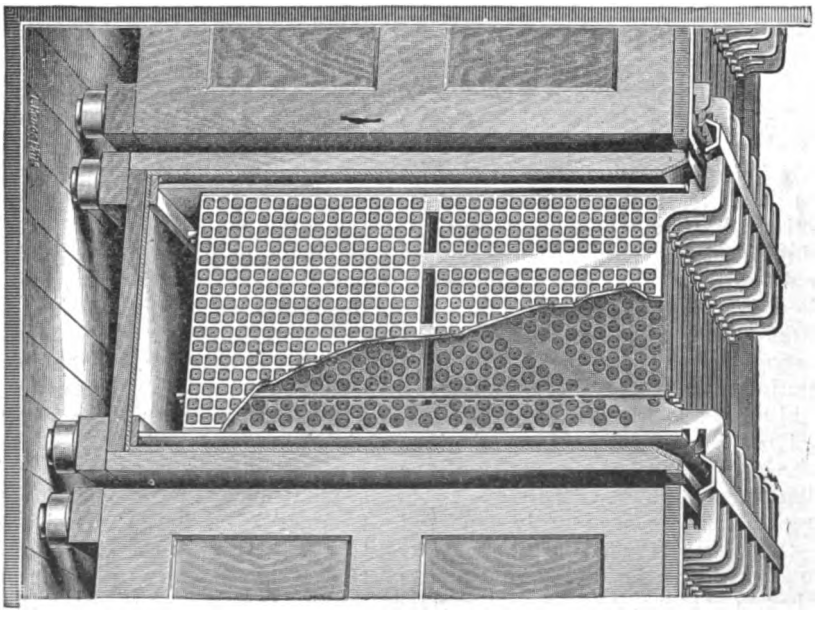


Type "F"—15 Plates, in Glass.

The success the chloride accumulator has met with is entirely due to its excellent qualities, and depends in no way upon the talking up usually depended upon for the success of other types.

The policy of the Electric Storage Battery Company has been from the very first to protect the users of storage batteries in their rights. To carry out this policy the Electric Storage Battery Company about three years ago acquired all the basic patents and patent rights underlying the manufacture of storage batteries whereby it secured to itself the sole right to supply in the United States all the important types of storage batteries developed to that time.

united effort to perfect storage battery practice has already been attended with excellent results, whereby the manipulation of battery plants has been made easier and longer life and higher efficiency given simultaneously to the cells.



Type "H"—15 Plates in Lead Lined Wooden Tank.

It is unnecessary to speak more fully of the advantages of a storage battery equipment. They are so self-evident that a little more patience on the part of the Electric Storage Battery Company will secure for them all the prestige and good will they may in the future desire.

Lewisburg, Tenn.—A new telephone line is to be constructed from Lewisburg to Thick.

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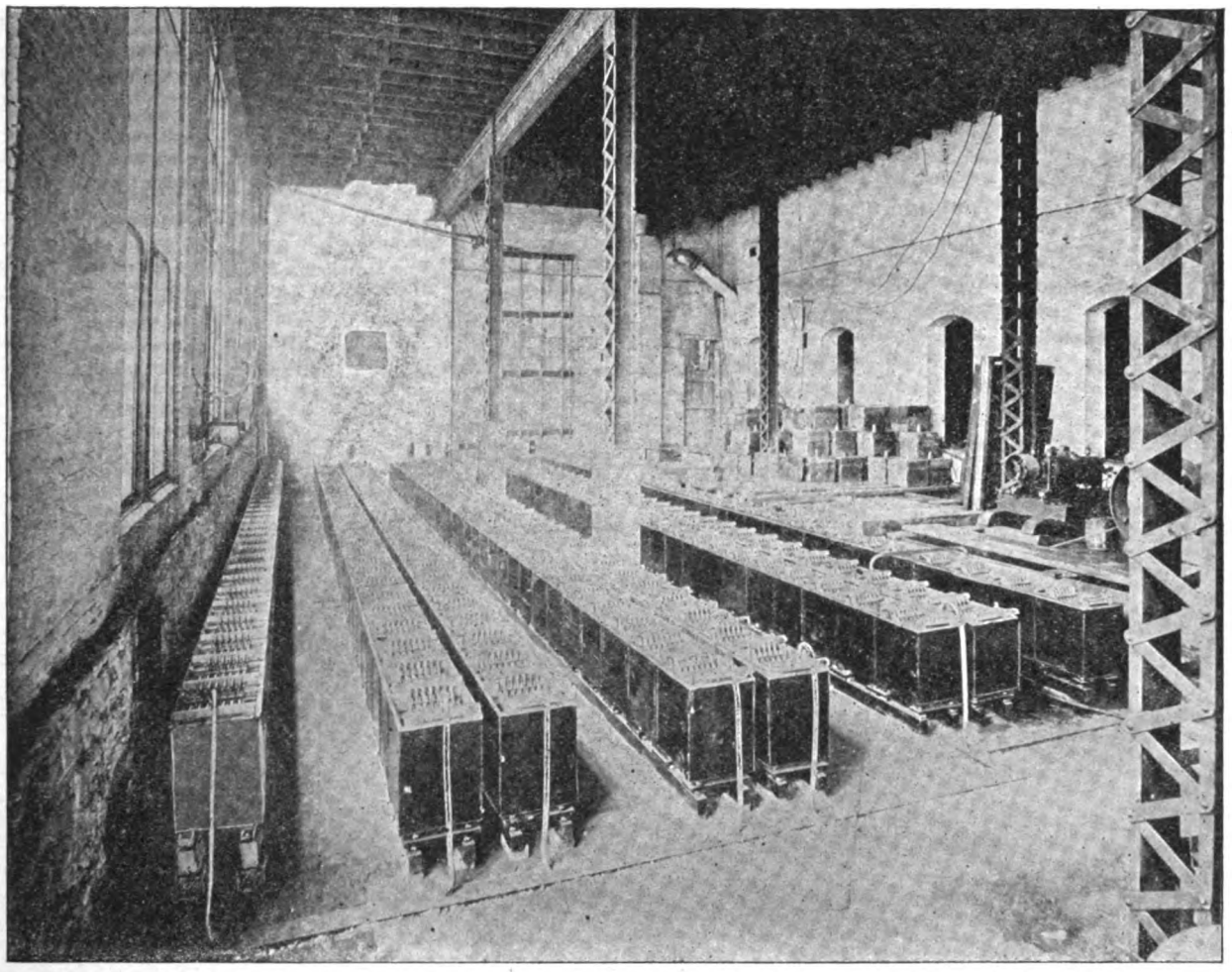
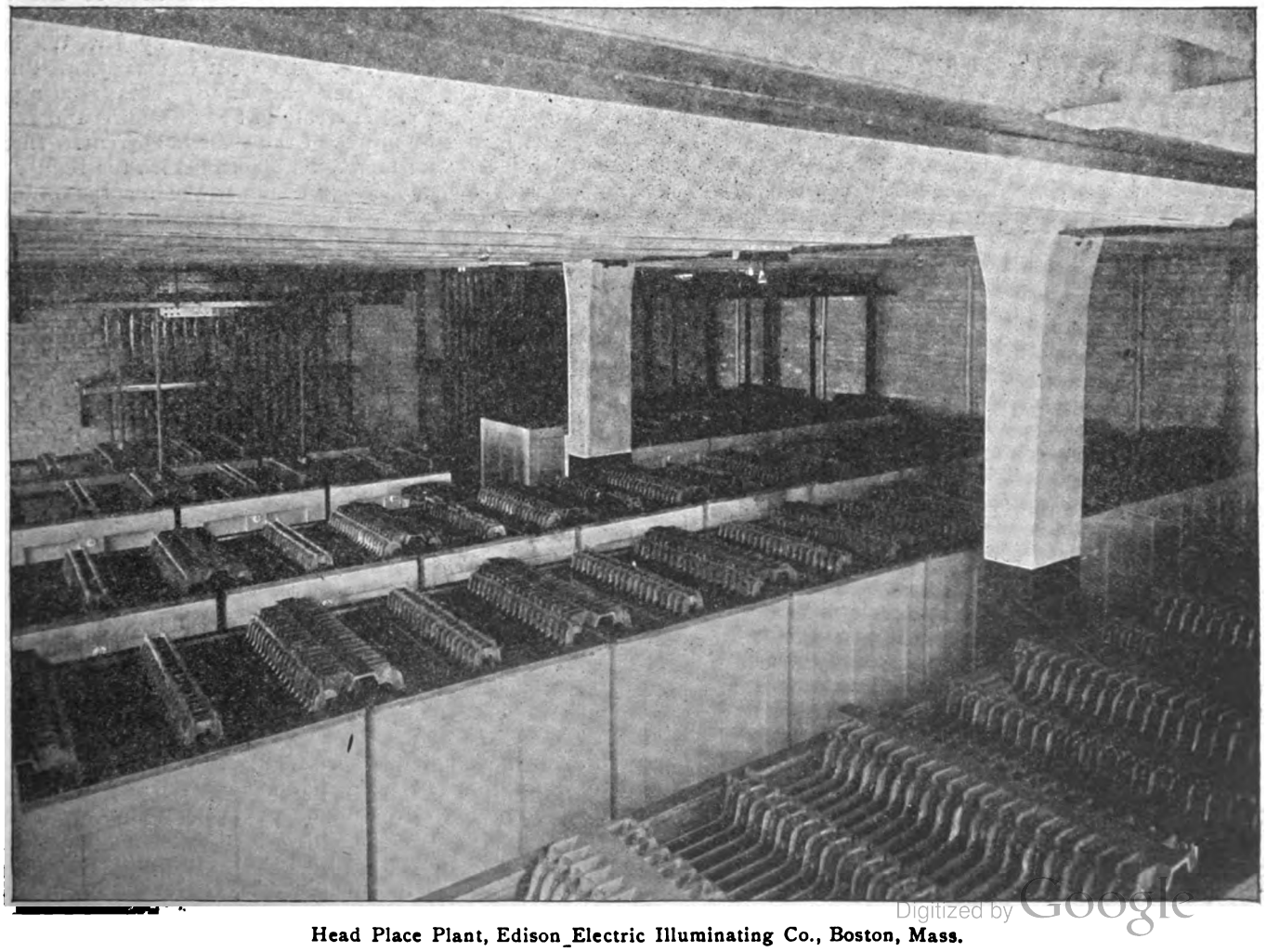


Storage Battery Plant at Oakland Station, Consolidated Traction Co., Pittsburg, Pa.



Head Place Plant, Edison Electric Illuminating Co., Boston, Mass.

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BOOK REVIEWS.

A revised edition of "The Elements of Electric Lighting," by Philip Atkinson, A. M., Ph. D., has been reissued by D. Van Nostrand Company, 23 Murray and 27 Warren street, New York. This is the ninth edition and came out at the close of 1897. Several chapters have been re-written and the book, as a whole, brought fully up to date. It treats of the generation, measurement, storage and distribution of electricity. It is written to be read, not alone by technical students but by thousands of interested laymen, who desire general information. The price of book, $1.50.

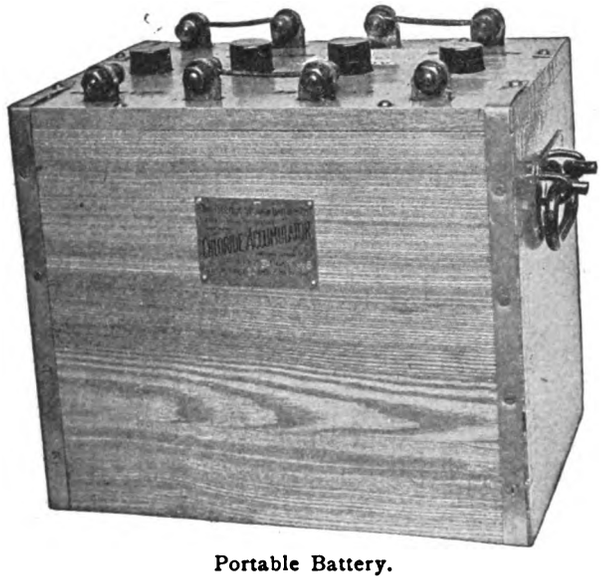
The Standard Electrical Dictionary, published by Norman W. Henley & Company, of 132 Nassau street, New York, is one of the most complete dictionaries of words, terms and phrases used in the electrical profession. It is a valuable book to the lay reader and one that cannot be replaced by the technical student. It covers the ground thoroughly and considers the lesser details relating to apparatus, methods, circuits and phenomena so exhaustively that a study of the science is directly possible by the aid of this book. A bird's-eye view may be taken of the electrical science in all its branches on examining subject matter of the "Standard Electrical Dictionary."

The present edition is the second published and contains a convenient appendix, with such other additions as bring it fully up to date, right to the front in the latest fields of thought. Artisan, electrical engineer and student of pure science will find this volume exceedingly valuable. 624 pp, 350 illustrations, price, $3.00.

"The Arithmetic of the Steam Engine," by E. Sherman Gould, is a small treatise written in an able and simple manner on the fundamental principles of the steam engine. In many respects this book will prove of the highest value to readers because of its simple character. It is true that all calculations are reducible to arithmetic, but it is likewise true that many simple formulæ are not available to the untechnical mind because the author has not given an example pertaining to the same. In the "Arithmetic of the Steam Engine" not only are the principles of steam engineering clearly set forth but instructive problems given and solved of the greatest benefit to those interested in any part of the profession. Mr. E. Sherman Gould is a member of the American Society Civil Engineers, and the author of a "Primer of the Calculus." D. Van Nostrand Company publish the above; price, $1.00.

"The Elements of Electro-Chemistry," by Dr. Robert Luepke, published by J. B. Lippincott Company, of Philadelphia, is probably one of the most able books written upon the subject of electro-chemistry of the closing century.

The subject of physical chemistry and of the various reactions and remarkable phenomena occurring in an electrolyte is one that has given rise to a variety of opinions and a host of theories. There are few scientists that have grasped the subject well enough to be able to speak with any degree of authority. But the volume on the principles and laws underlying electrolytic action by Dr. Robert Luepke is certainly worthy of the greatest attention by electrical engineers. A better comprehension of this subject will mean a quicker solution to the greatest of modern problems, the production of electricity direct from coal. It is therefore advisable for all desiring to be scientifically well informed to review the pages of Dr. Robert Luepke's "Elements of Electro-Chemistry." Price of book, $2.50.



Portable Battery.

"Electric Smelting and Refining," by Dr. W. Borchers, published by J. B. Lippincott Company, of Philadelphia, is a perfect compendium of facts relating to electro-metallurgy. It treats of the extraction and treatment of metals by means of the electric current. In our opinion it does far more. It places before the reader all known and legitimate methods in vogue for the refining and smelting of ore. The illustrations save the author from dealing in abstractions and give the reader a healthy interest in the subject matter under notice. The book is divided into parts. The first treating of alkalies and alkaline earth metals; the second treating of the earth metals; the third the heavy metals, and thereby taking into consideration gold, silver, iron, mercury, tin, lead, etc. The volume is in every sense complete, up to date and, through the aid and care of Walter G. McMillan, clearly and ably translated into good English. Dr. Borchers is a great authority on this subject and his translator, McMillan, is a lecturer on metallurgy in Mason College, Birmingham. and an author of electro-metallurgical works likewise. The book is sold for $6.50.

"The Power Catechism," published by the Power Publishing Company, New York, contains the correct answers to direct questions covering the main principles of steam engineering and the transmission of power. "The Power Catechism" is compiled from the regular issues of "Power" and is intended for special assistance in preparation for examination or where direct information is desired. The way the public is best taught is by a method of questions and answers. The very best sources of information have been utilized in supplying the proper material for this choice catechism. Not only will the above book teach the reader and practical man what is best to do, but be of the greatest assistance in the diagnosing of troubles that all steam appliances, engines, etc., are heir

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to. The practical man and student of steam engine design will find this book a valuable aid in all work that he may contemplate. A great deal of excellent data is added which will save considerable time in calculations.

"Scientific American" has issued a bound supplement, containing a catalogue of valuable papers. It is of the greatest use to the reader, as it will guide him in obtaining information on a multitude and wide range of subjects. The cloth bound copy is called "The Scientific American Supplement Catalogue" and covers the matter treated of in the supplement proper. It is supplied on application to subscribers by Munn & Company, publishers, 361 Broadway, New York.

"American Telegraphy, Systems, Apparatus and Operation," written and published by William Maver Jr., 27 Thames street, New York, is a most complete book on telegraphy extant. It covers the subject of telegraphy in all its branches and takes into consideration every detail relating to the operation of any given system. Mr. Maver has certainly a thorough grasp of the subject, as shown by descriptions of the utmost value to technical readers. Not only is the ordinary Morse system described but the use of the dynamo in telegraphy, the function of the condenser, galvanometers, line testing, Delaney system, automatic writing, submarine and synchronous telegraphic systems, as well as automatic burglar alarms, railway electric clock signalling systems and innumerable facts relating to the care, supervision and operation of each. Considered as a whole, no volume treating the subject could be more interesting, more up to date and complete than Mr. Maver's work on American telegraphy. The volume is profusely illustrated, containing as many as 450 cuts, and is far above the plain or the mediocre in every respect. We strongly recommend this book to such of our readers as desire real information on the subject of telegraphy. It is certainly the best ever written.

TELEGRAPHING WITH AND WITHOUT WIRES.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

Differential Winding.—When a magnet core is wound with wire half way in one direction and the remainder in the opposite direction, a current passing through it would produce no magnetic effect. One set of turns would neutralize the other and the magnet or relay remain unaffected.

Duplex Telegraphy.—The system of sending and receiving a signal at the same time over one wire is possible in the following manner:

Home end unaffected by outgoing signals.—The operator desiring to send a message out does not want his relay disturbed under such circumstances. If the relay used is differentially wound, and the current is sent through it, the outgoing signal leaves it unaffected.

Balancing the line.—The differential relay is supplied with two opposite windings; when the current issues from the station it is necessary to preserve each winding of the same strength, the one connected with the outside line and the other connected to the earth. If one of the differential windings connects to the line which possesses

Resistance and
Capacity,

the other grounded to the earth requires an artificial equivalent of the same. A condenser and a rheostat are therefore inserted between it and the ground connection.

Artificial line.—When a current is sent out, one half goes through one of the windings of the differential relay and then on to the main line; the other half passes through the remaining winding to the earth.

Current in each winding of differential relay alike.—By this balancing up of the real line by artificial means the current is equally split in each of the relay windings and it is totally unaffected by an outgoing signal.

Dircetion of current and signal.—It may be known that a false opinion prevails regarding the direction of a current and a signal. It is not necessary to have both current and signal moving in the same direction. A signal sent from one end of a line may be due to a current leaving the other end and vice versa.

In this case the single-current duplex, the outgoing current, leaves the station unaffected; but it is still sensitive to signals sent in from the other end, although these signals are only received by more current being drawn from the first end.

Diagrammatic Explanation.—In the diagram these principles are illustrated as follows:

(1) Signal sent out: K is depressed,
D is attracted,
O is lifted,
B supplies current to point *a*, where it divides between 4 and 2; one half through differentlal winding and 3 to line; the other half through differential winding, 5, C and X to earth. Result, relay unaffected.

(2) Signal being received.
Batteries at other end in series with B,
K depressed at other end,
More current drawn from 3 station sending signal,
Strengthens one of the differential windings;
with the result that relay operates and works its sounder. Both keys at each station may be simultaneously pressed, yet each station receives what the other has sent without interference.

The technical names of the principal devices used in this system are the

Transmitter	K
Differential Relay	M
Rheostat	X′
Condenser	C

It is absolutely necessary to keep the line balanced at each end, otherwise the sending of signals is impossible without working the relay.

Signals travelling in opposite directions do not mean currents opposing each other. In this system, according to diagram, the current producing a signal passes through line, 3, 2, n, 9, 6 to earth.

QUESTIONS FOR REVIEW.

(1) Who invented the electro-magnet? the telegraph?
What is a sounder?
What is the line?
(3) Explain the meaning of a
Duplex,
Diplex,
Multiplex system?
(4) What is a relay?
What is a neutral relay?
What is a polarized relay?
What is a differentially wound relay?
(5) What does a duplex system consist of?
(6) Outline its operation.

The Quadruplex.—The meaning of a quadruplex system of telegraphy may be traced to a combination of two systems, the single and double-current duplex systems.

Double-Current Duplex.—The explanation of the quadruplex necessarily involves the analysis of the double current duplex upon the basis of which a four-message system on one line becomes possible. In double-current

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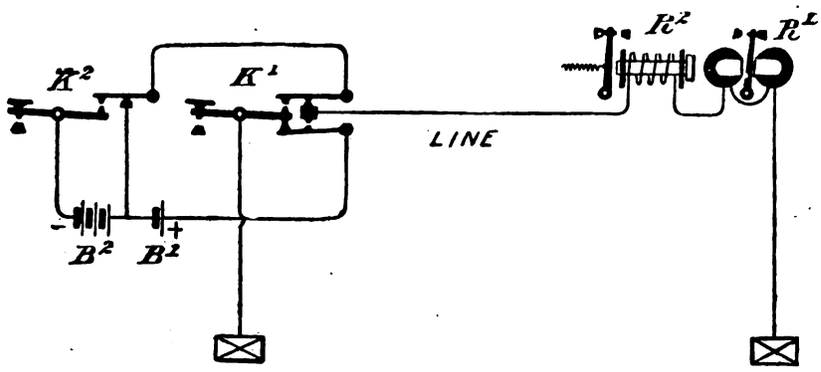
duplex work a double-action key is employed at each end of the line. When either is depressed they reverse the direction of the current without breaking the circuit.

Polar Relays.—The use of the polar relay is found in this method of telegraphing, and it serves the following purpose: When current is sent into a polar relay, the relay is only effective in opening or closing the circuit when the current flows in a given direction. A polar relay is an electromagnet whose armature is a magnetized piece of steel. The steel, having poles, is attracted either one



Basis of Quadruplex.—Duplex Telegraphy.

way or the other according to the polarity of the electromagnet, the polarity of which is determined by the direction of the current circulating in its coils. A polar relay therefore possesses a polarized armature; an armature with poles.

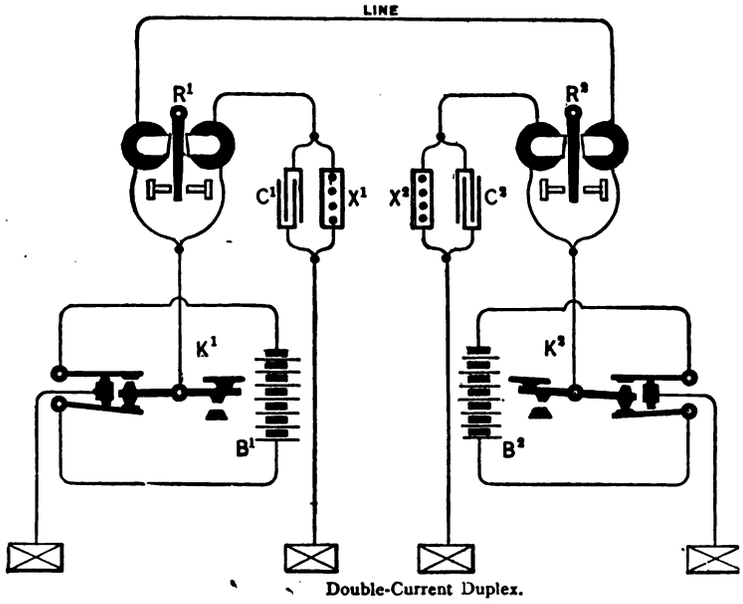
Polar relay differentially wound.—The relay, if differentially wound, will leave the armature unaffected even with a current circulating at the same end as that at which the key is depressed. This current at the distant end is received by the station at that point, and operates the relay there. When the key is depressed a current issues outward, a positive current; when it is raised a current enters, a negative current. The direction of the current sent out therefore is the only means of affecting the polar relay at the other end, and this system may be distinguished as one dependent upon direction and not volume, as in the last single-current duplex system. While one end is sending a message the other may be also doing likewise; both signals are therefore sent and received at the same tine at each end respectively.

The System.—The artificial line is supplied in this as in the single-current system, and the main point to recollect is the fact that it involves the use of a double key at each end, which reverses the current, and a differentially wound polar relay sensitive to such changes.

Quadruplex Telegraphy.—For the quadruplex transmission of signals a double set of keys is used. One similar to the last described performs the function of reversing the current. The other merely controls the current of greatest strength.

Its Principle.—Perhaps the fact has been already noted that in single-current duplex telegraphy, the relay is affected by the changes in the strength of the current, and in double-current duplex entirely by the direction of the current. It seems evident that upon this basis a double system could be constructed, such that either the strength of current affected one relay or the direction of the current the other; and with this combination, currents could be sent and received depending upon their quality to the extent of four at one time.

Polar relay and neutral relay in series.—By having both the polar and neutral relays in series, a given direction of current will only affect the polar, and a given strength of the neutral relay. Two keys are therefore used controlling each condition.



Double-Current Duplex.

Double-Current Duplex.

The reversed currents moving the polar relay are too weak to operate the neutral relay, therefore it is exempt from that influence, being entirely under the control of the stronger current sent forth by the other key.

An electrostatic discharge sets into action ether waves of varying duration and intensity. The experiments of Dr. Hertz, Prof. Lodge, Prof. Marconi, and Prof. Rhigi have been fruitful in showing a method of telegraphing or signalling without wires. If an electric circuit, consisting of bell, batteries and a tube filled with metallic powder be so placed as to be swept by the ether

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TELEGRAPHING WITHOUT WIRES.

It is well understood that logic is the lever of human progress. But it seems to be likewise true that human reason is deficient and useless as far as its relation to certain consequences or results may be concerned. It has often happened that the first crude experiments performed elucidating a known principle and showing certain tremendous possibilities in the near future have been cried down by men of high standing. This prejudice, bias or antagonism, is not always the result of careful thought, but frequently due to impulse or egotism. The perversity of the human mind is such that it will face truth unflinchingly and yet deny its existence. It will stand with brazen face before a well-based enthusiasm and decry it. There are some that so fully rely upon their extensive knowledge in certain departments of science as to believe that their word is infallible and their opinions unassailable whenever advanced.

At present the future of wireless telegraphy is surrounded by the same clouds of doubt as have attended the appearance of other great inventions. The conservative have passed beyond the limits of conservatism. They do not speak of the limitations of this system, but of what they consider its greatest deficiencies, its most salient causes of failure.

Looking upon the progress that has thus far been made, unbiassedly, we are forced to conclude that in its present inchoate condition it is almost impossible to give issuance to an opinion that can stand the light of scientific criticism. The experiments made abroad and the energy and persistence with which they have been carried on in this particular field of experiment show conclusively that many practical men are firmly convinced of the present and future value of this remarkable system of telegraphic communication. We have so accustomed ourselves to dealing with what we consider the most material that we have forgotten that it is illusive and as unreal in its inherent nature as many other scientific phantoms have been.

The transmission of signals without wires, strikes us as wonderful because it is novel; yet we must remember that familiarity with snch a system will quickly remove the newness and make it appear as prosaic as the ordinary Morse system, which in its day was considered the greatest marvel of the century. The production of etheric waves controlled in intensity and quantity by special apparatus is certainly not an abstract problem, but one which seems to be in perfect harmony with our present progress. The objections advanced by some of our authorities against the further development of this system are not based upon practical experiments and exist only in the minds of their originators. The world is waiting for a new departure. It actually requires a newer system of communication and scientific men cannot but concede that the use of Hertzian waves is the best, most plausible and most practical method of establishing communication between distant points that the mind of man has ever evolved.

The problem at present is one of comparative simplicity. It relates to the construction of two circuits in electrical resonance with each other, whose resistance, self-induction and capacity are tuned so that action in one will produce a response in the other. It likewise relates to the distance waves of given amplitude can travel and still retain sufficient energy to operate the distant coherer.

It is therefore evident that the limitations of wireless telegraphy are not known, and that investigation carried on systematically with a scientific basis will supply us with data that will be productive of conclusions of direct practical value. Let us but know the penetrative power of Hertzian waves, the most sensitive type of coherer for receiving them, and we can draw conclusions as to the reach and commercial value of wireless telegraphy. Until then the question lies in abeyance, and no opinions are of any value unless based upon purely practical experiments.

* AMERICAN COMPETITION IN EUROPE.

The year now drawing to a close will be remembered as an epoch in the industrial and commercial relations between the leading European countries and the United States. The remarkable fact of 1897 has been the enforced recognition of the truth that in several important lines of manufacture—notably that of iron and steel—the scepter of economical production, combined with payment of the highest wages to labor, has passed from the Old World to the New.

For years European economists have struggled against the conclusions which practical men are now forced to accept. It has been argued that, through what they regarded as a false fiscal policy, and the exaggerated wages accorded to labor, high cost of living, and lack of general technical education, American manufactures, in which labor formed an important percentage of cost, could never seriously compete in the world's markets with the low wages, frugal living, and patient twelve-hour toil of the Old World, where, in many places communities have been trained for generations in specialized forms of industry.

But it has been demonstrated that, under intelligent, progressive management, highly paid labor, especially when employed to use complicated machinery, is, after all, the cheapest, and that in the race for supremacy the inert, congested populations of the Old World have been in many cases left behind by the people who, more than any other, have reduced economy of labor to an exact science. Says Mr. Jeans, Secretary of the British Iron Trade Association, an expert of the highest authority in his profession:

(Continued on page 94.)

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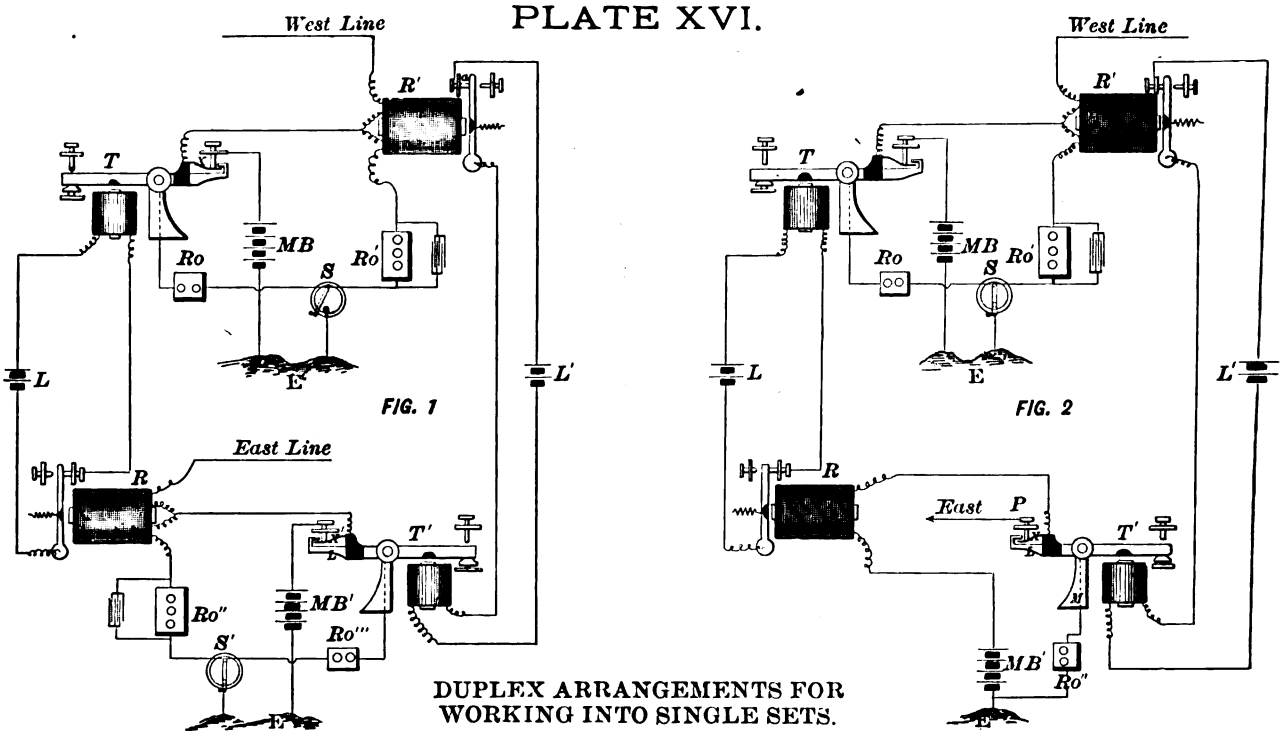
waves proceeding from a discharge of an electrostatic nature, the current will flow through the circuit just mentioned only when the waves affect the tube. The parts comprising an outfit that dispenses with wires are a

PLATE XVI.



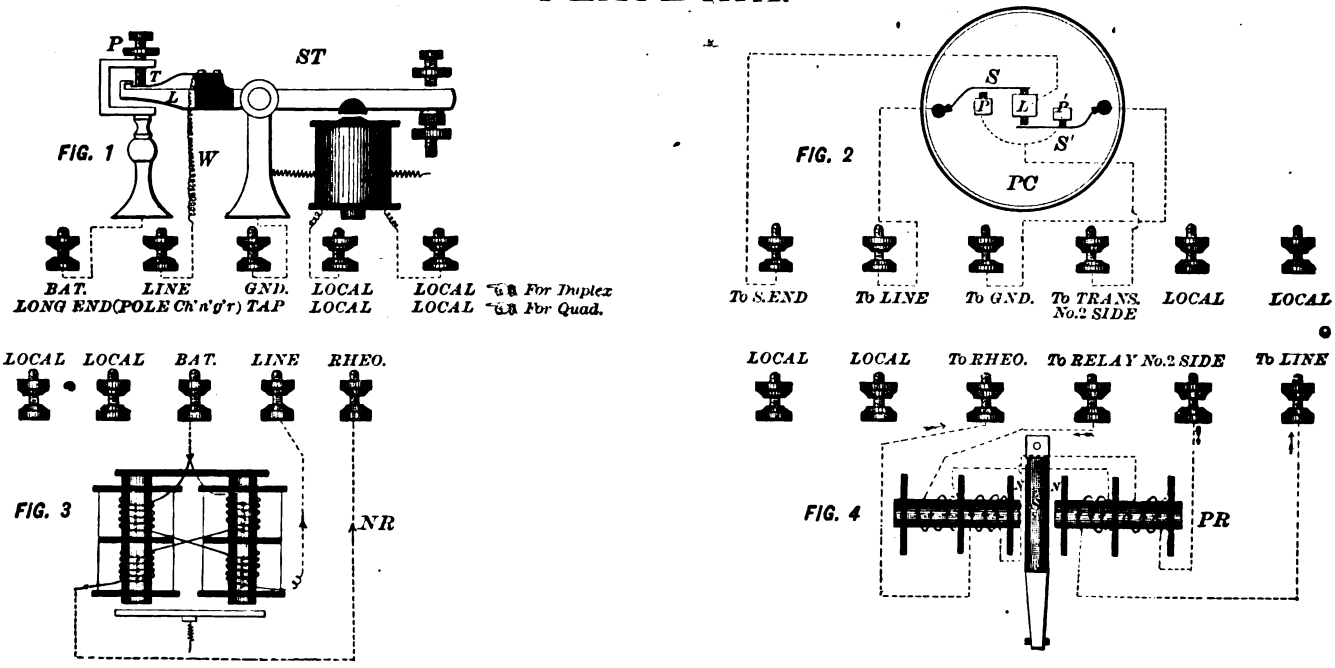
DUPLEX ARRANGEMENTS FOR WORKING INTO SINGLE SETS.

Transmitter,
Coherer,
Relay.

The last two are used conjointly the coherer forming part of the circuit operating the relay.

The transmitter consists of two or more brass spheres insulated from each other and connected to a spark coil, operated in the usual manner. The discharge of the coil may occur in air or in a tube filled with oil, the brass in each end reaching almost to the centre, the space between the metal plugs being filled with metal filings. The coherer is in circuit with a simple relay and dry cell. If the filings lie loosely arranged, the current will not operate the relay, but if the proper adjustment is made so that the coherer is in resonance with the transmitter, the waves proceeding from the same will affect the filings in the tube, close the circuit, and operate the relay; unless means are taken to decohere the filings in

PLATE XIX.



DUPLEX & QUADRUPLEX APPARATUS.

balls forming plugs at each end. The high potential discharge taking place between the knobs originates waves in the ether, which travel forward similar to sound waves, though differing from them in character. These waves travel with the rapidity of light. It is not necessary to the tube, the signalling apparatus operating by its aid will continue to give signals, that is, if it be a buzzer or bell. But, if a decoherer is made use of, which vibrates the filings and thus mechanically opens the circuit after the ether wave has passed, the signal will cease when the

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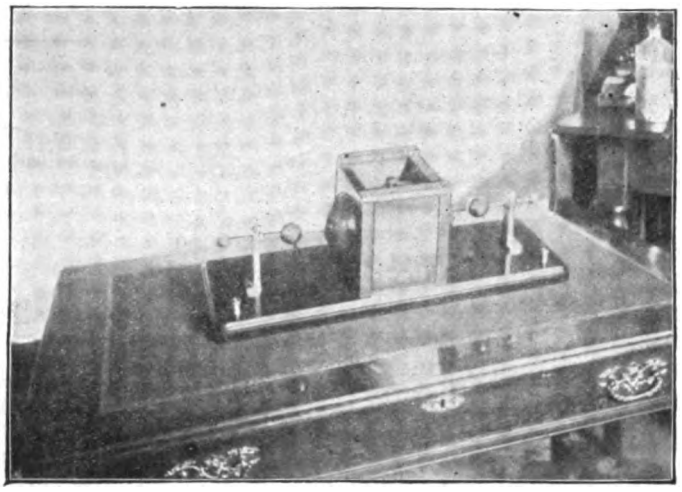
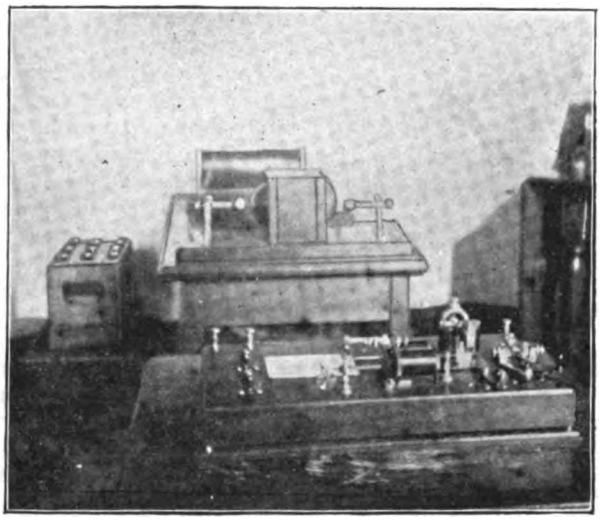
sparks in the transmitter have died out.

The resonance of any two circuits or any number of circuits depends upon the relations existing between their



Device Producing Hertzian Waves Used in Wireless Telegraphy.

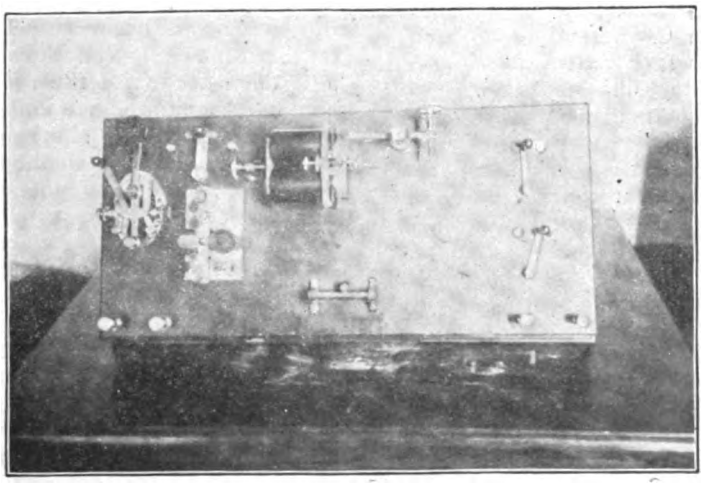


Complete Outfit for Wireless Telegraphy, Including Spark Coil, Transmitter, Coherer and Morse Telegraphic Apparatus.

individual capacity, self-induction and resistance. It may be said therefore that the circuits are tuned electrically to each other. The transmission of signals over long distances is possible if two general courses are pursued.

First, the production of very heavy discharges without a mirror; second, the use of weaker discharges with a mirror or reflecting device.

The investigations of Bjerknes have shown that the height of electric waves changes as they recede from their origin, and that long waves are preferable to shorter ones for long-distance signalling. The use of very powerful discharges is necessary for the production of long waves and by using a mirror the rapid decay that ensues can be temporarily delayed. A light wave travels with uniform amplitude, that is, moves with the same sized



Board Mounted with Sounder, Key and Relay with Coherer in Circuit. (Coherer at Lower Part of Board in Middle.)

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waves, but it differs in this respect from a Hertzian wave, which constantly decreases as it recedes from the transmitting spark gap.

With Clark's apparatus it is possible to signal over distances of several miles. It consists of a spark coil, a transmitter, composed of an oil cylinder and discharge knob as above described, which send the Hertzian waves forward. The receiving device comprises a coherer, Morse telegraphic outfit, sounder and relay. The waves strike the coherer, thereby allowing the battery current to act, operating the relay. The filings in the tube are separated by a slight air-gap and the coherer is prevented from packing by means of a vibrator, which automatically taps it whenever the relay operates. Very distinct signals are produced by this apparatus.

Signals have been sent and received a distace of eight miles, and the future possibilities in this particular field of work can hardly be gauged off-hand. Its most valuable feature is its simplicity, and the future service it will be capable of giving depends entirely upon the extent to which resonance can be established. Privacy can only be preserved by an observance and careful study of methods of tuning the two circuits. Information at present is rather meagre concerning experiments that have been made, but much is expected in the near future.

QUESTIONS FOR REVIEW.

(1) What is a quadruplex system of telegraphy?
(2) Describe its most prominent features.
(3) What principle is involved in wireless telegraphy?
(4) What is a transmitter?
(5) What is a coherer?
(6) How is the coherer kept in working order?
(7) Under what conditions are the signals kept private?

Cleveland & Taylor, electrical engineers and contractors, No. 5 Dey street, New York, beg to announce to their friends and patrons that on and after February 15, 1898, their office and factory will be found at No. 23 Dey street, Havemeyer Building, New York City. Telephone number, 4677 Cortlandt.

REMOVAL.—We beg to advise our patrons that we have leased the store No. 23 Dey street, Havemeyer Building, and that we will move our place of business to the above address on or about February 15, 1898.

Pass & Seymour,
Crouse-Hinds Eectric Co.,
F. M. Hawkins, Agent.

The Steel Storage and Elevator Construction Company, according to "Greater Buffalo," which last month moved its headquarters from Connersville, Indiana, to this city, in order to secure a more central location with reference to its field of operations, has experienced great prosperity since the change was made. Within the last four weeks the company has secured contracts for the erection of four steel storage elevators in different parts of the country, as follows: an elevator of 100,000 bushels capacity for the Decatur Cereal Mill Company, of Decatur, Ill.; two elevators of 200,000 bushels capacity each for the American Malting Company, one at New York and the other at Chicago; and an elevator of 50,000 bushels capacity for Frederick Reynolds at Bellefonte, Pa. The Steel Storage and Elevator Construction Company built the new electric elevator, of 1,000,000 bushels capacity, and which is operated by Niagara Power, in this city.

"I know of cases where the labor of a ton of billets and rails is 25 to 35 per cent. less in America than the lowest cost I have ever heard of in this country, although the rate of wages paid in America is materially higher.

* Frank H. Mason, Consul General, Frankfort, Dec. 31, 1897.

(To Be Continued.)

"GOLD STANDARD" ELECTRIC HEATERS have been adopted for the entire equipment of the South Side Elevated Railroad of Chicago. The equipment of this road with the Sprague Electric Company's system of pro pulsion of cars is rapidly nearing completion.

PHŒNIX ELECTRIC TELEPHONE COMPANY.

The growth of the telephone industry in this country has been very rapid in the last few years. But in spite of the fact that everyone is interested in this rapid and convenient way of sending messages, we do not average the same number of 'phones per hundred citizens that some of the more conservative countries in Europe have for years past laid claim to. The public are by this time thoroughly well acquainted with the benefits of rapid communication. They cannot fail to understand the superior advantages offered by a well installed system, yet due to some reason, the Americans are a little behind their European neighbors in the use of the telephone. But there is every evidence that in the near future one of the most familiar objects in a private house will be a telephone, which will eventually become an essential part of a household equipment—as necessary as the kitchen range and as useful as other common household accessories.

The Phœnix Electric Telephone Company, of 93 Washington street, New York, control the patents of the Sutton microphone, patented June 2, 1896, and magneto-bells with automatic cutouts, patented November 10, 1896. They have been in touch with the desires of the public and anticipated the general demand which now rolls in for telephone systems. Possessing a microphone which is certainly one of the clearest and best transmitters manufactured by any electrical concern, they realize that the public need merely be a little better acquainted with their apparatus to become fully assured of its incontestable virtues and superiority over similar devices. Their long-distance granular carbon telephone contains all the improvements worthy of note, including the Sutton transmitter, patented 1896. Using a granular carbon microphone, unaffected by atmospheric changes and free from the deficiencies of all other types, it may be said that in no respect can even the Anthony White compare or compete with this particular type. The generators, bells and automatic switches supplied with the Phœnix Electric Telephone Company's outfits are of the most reliable make and certainly ensure success to all that are fortunate enough to choose so excellent an outfit.

The battery telephones of the above company are guaranteed in every respect. The manufacturers feel certain that upon trial they will secure a good customer, and therefore invite the readers of this article to come and see what they have done in this broad field of work. They make a great many types of transmitters and receivers; their desk telephones being well received by all customers. The desk 'phone consists of a standard Blake transmitter box, with switch standard receiver, mounted on a niekel-plated standard. Magneto or battery call bells are used to signal with. These outfits are cheap and highly efficient. In addition they sell standard receivers mounted on arms, as shown in illustration.

Their new improved switchboards with self-restoring drops, each drop and jack combined, occupying a minimum of space, have attracted considerable attention on account of their compactness, certainty of action and general excellence. All that relates to telephonic apparatus is manufactured and sold by the above company, who believe in the axiom known to all practical workers, "that things done by halves are never done right." Correspondence is solicited on all matters or installations relating to telephonic apparatus at the address given, 93 Washington street, New York.

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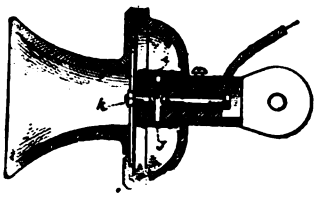
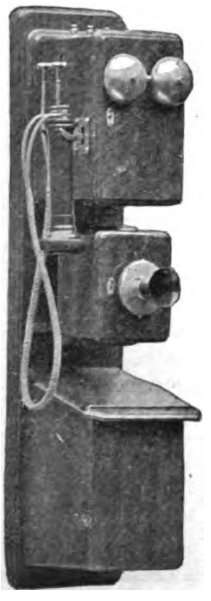


Sutton Microphone.
Patented June 2d, 1896.

Style No. 4.

Desk Set No. 7.



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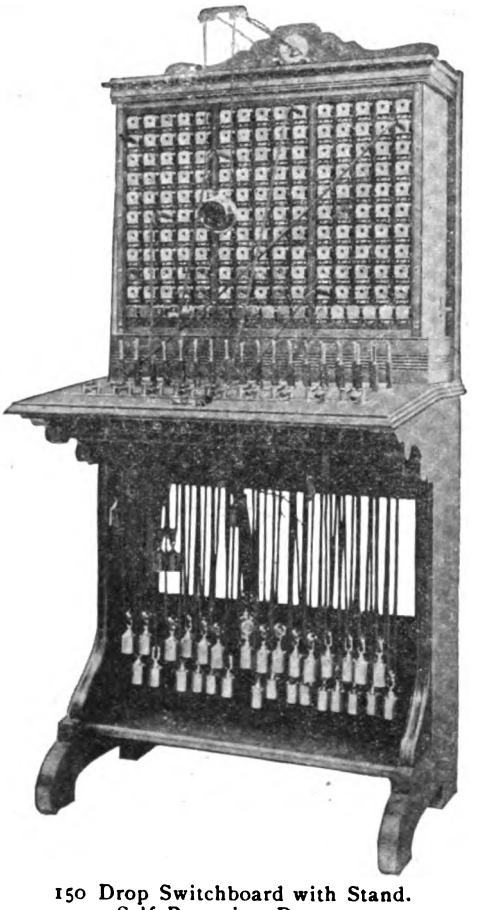
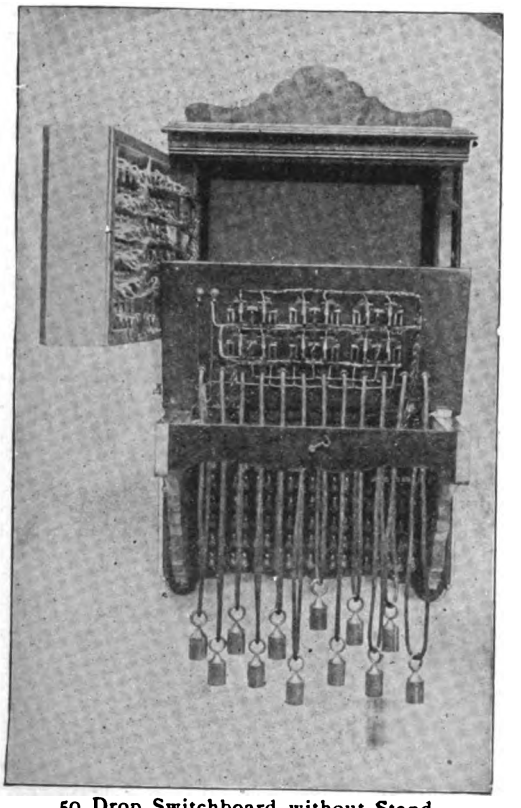
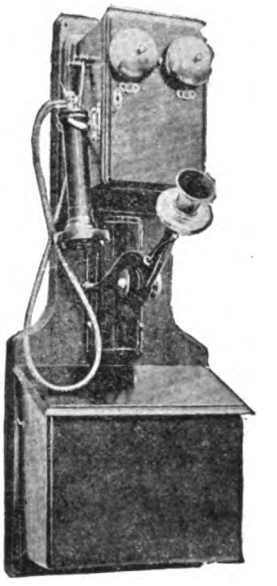


150 Drop Switchboard with Stand.
Self Restoring Drops.
Patent Pending.
Each Drop and Jack occupy a space of 1½ ins. square.
100 Drop Board, 15 ins. square.



50 Drop Switchboard without Stand.
Thrown back on hinges, showing Jacks and Magnets.
Table thrown up, showing Switching Movements.



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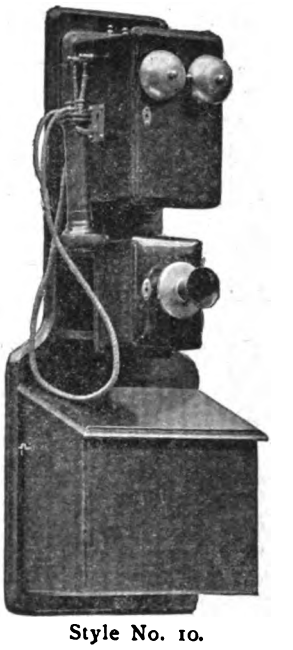

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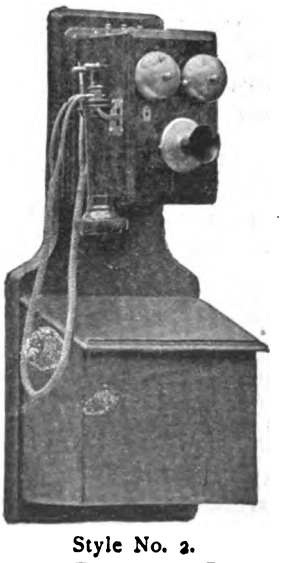

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NOTES.

The new and attractive works of the John Stephenson Company (Ltd.), at Elizabeth, N. J., is creating considerable attention, especially the great tower containing the largest electric clock in the world. Mr. Charles H. Davis, the prominent electrical and mechanical supervising engineer of Cedar and Church streets, New York, the president of the company, expects to have the works in operation about March 1st. 48 Lundell motors are to be installed, direct-connected, and geared to the variety of machinery used in building electric street-railway cars for which the Company is so well known.

ELECTRIC VEHICLE COMPANY, 1684 Broadway, N. Y., has ordered 100 new cabs for New York service, all of which will be operated by chloride accumulators, made by the Electric Storage Battery Company, of Philadelphia and New York. Charles Blizard, New York, manager.

H. B. COHO & COMPANY, St. Paul Building, N. Y., manufacturers of switchboards, switches, repairers of dynamos, motors, etc., have the contract to make and fit out the big board for the big lighting and power plant for the new building of the John Stephenson Company, Elizabeth, N. J.

UNIVERSAL ELECTRIC COMPANY, 126 Liberty street, N. Y., are furnishing fifty of their lightning arresters to use in the lighting and power plant of the John Stephenson Company Works.

O. B. Greene has opened offices at 102 Fulton street, New York, where he has established agencies for all kinds of electric light and power supplies, and where he will conduct a general construction and repair agency.

NEW YORK ELECTRICAL SOCIETY.

The 185th meeting of the Society was held at the College of the City of New York, 23d street and Lexington avenue, on Friday, February 11, at 8 P. M., in conjunction with the New York Section of the Amercan Chemical Society.

Mr. Joseph Wetzler lectured on "Electricity Direct from Coal." (Illustrated by lantern.)

Dr. G. F. Barker, of the University of Pennsylvania, gave an address on "The Status of the Physical Relations of Electro-Chemistry," and Dr. Edgar F. Smith gave an address on "The Application of Electricity to Chemical Analysis and Laboratory Research."

GEORGE H. GUY, Secretary.

NEW ELECTRICAL INCORPORATIONS.

Britton, S. D.—The electric light plant is about completed.

Dalton, Ga.—The mayor may be addressed for information concerning erection of electric light plant.

White Castle, La.—Colonel James A. Ware is interested in the establishment of an electric light plant.

Glens Falls, N. Y.—The Consolidated Electric Company has been incorporated by E. J. West and others. Capital stock, $10,000.

Schoolcraft, Mich.—City clerk may be addressed concerning establishment of electric light plant.

Indianapolis, Ind.—The Jenney Electric Plant will rebuild plant which was recently burned.

Rochester, N. Y.—The Rochester Electrical Manufacturing Company has been incorporated with a capital stock of $50,000.

Council Bluffs, Iowa.—The Carson Electric Light Company has been incorporated by William Holtze, David A. Snapp and James S. Campbell, and they will soon commence the erection of a plant at Carson.

McComb, Miss.—The mayor may be addressed concerning establishment of electric light plant, for which Sanders & Porter, of Louisville, Ky., will prepare plans.

Washington, D. C.—The Standard Cold Electric Light Company has been incorporated, with John Boyd as president, to manufacture electric lights for surgical use. Capital stock, $100,000.

Charlotte, N. C.—J. A. Helvin has secured franchise for construction of telephone system.

Lusk, Wyo.—A telephone line has been constructed between this city and Manville.

Litchfield Minn.—A company has been formed to put in a local telephone system to be extended over the county.

Westminster, Md.—The Westminster Maryland Telephone Company will issue bonds for $8,000 to provide funds for extending its telephone lines to Baltimore City.

Baltimore City, Va.—The Virginia Electric Company has been incorporated with A. D. Bodson, secretary and treasurer. Capital stock, $1,000,000.

Kansas City, Kan.—A large electric power house will probably be erected for the manufacture of electricity.

New Rochelle, N. Y.—The Huguenot Electric Street Railway Company has been formed by Louis K. Fries and Jacob M. Schuyler, to construct an electric line 11 miles in length.

Stanton, Mich.—An electric railway is to be constructed from Grand Rapids to Belding, Stanton, Crystal, Ithaca, and Saginaw.

Kansas City, Mo.—The Kansas City, Lawrence & Topeka Electric Railroad and Power Company, which was granted by the secretary of state a charter, a few days ago, has been organized under this charter in Kansas City, Kan. Capital stock, $3,000,000.

South Pittsburg, Tenn.—The East Tennessee Telephone Company has just completed an exchange at South Pittsburg.

Casper, Utah.—M. M. Maghee will put in an electric light plant.

Tipton, Ohio —A company has been organized for the purpose of constructing five miles of electric railway to connect with Atlanta, on the southern edge of the county.

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Telephone Users (INTENDING)

are reminded that the next quarterly issue of the TELEPHONE DIRECTORY will go to press on March 1st. To obtain the advantage of listing in this issue of the directory it will be necessary to make contracts during the present month.

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18 Cortlandt, 15 Dey, 952 Broadway, 115 W. 38th.

ROCKING GRATES. DUMPING GRATES.

Send for Circular. Mention "THE AGE."

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39 & 41 Cortlandt St., New York.
Taylor Bldg., Room 131.

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Contains 75,000 code words selected from the OFFICIAL VOCABULARY with phrases, numbered 00000 to 74,999. Used by the LEADING BANKERS AND MERCHANTS throughout the world, and acknowledged the best code extant. Over 4,000 soldsince date of issue, January, 1896. THE ONLY CIPHER CODE ever offered the public in connection with which each purchaser receives bi-monthly a list of those using it.

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Contains 25,000 code words arranged in tables, numbering 75,000 to 99,999.

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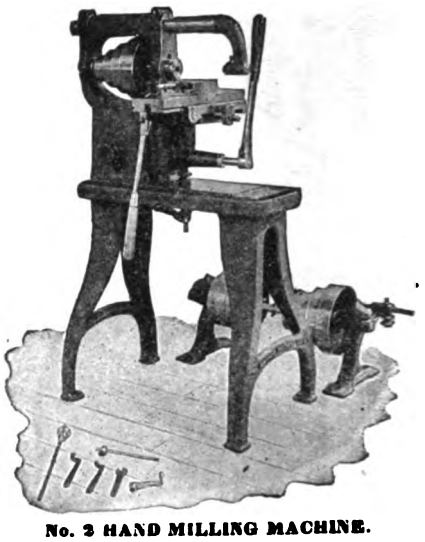

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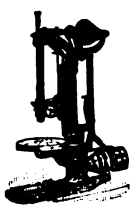

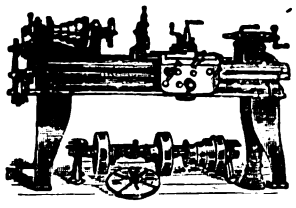

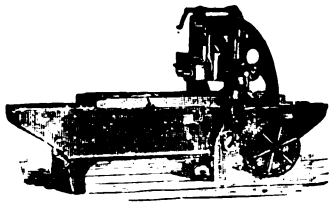

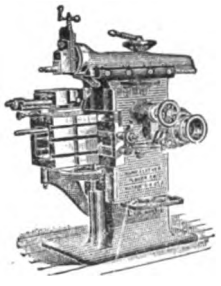

MILLING MACHINES, SCREW MACHINES, DRILL PRESSES, PROFILERS, HAND LATHES, TAPPING MACHINES, GEAR CUTTERS, SCREW SLOTTERS, CUTTER GRINDERS, DIE SLOTTERS, WIRE COILERS, SURFACE GRINDERS, MILLING CUTTERS, ETC.

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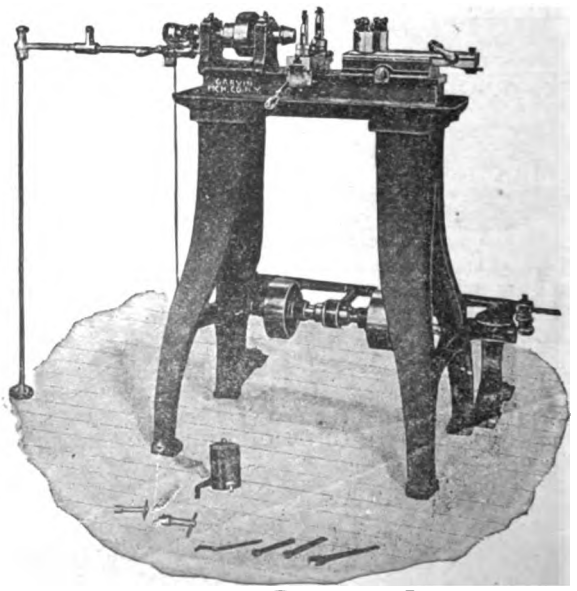

No. 00 SCREW MACHINE (WIRE FEED).

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The Electrical Age.

VOL. XXI—No. 8 NEW YORK, FEBRUARY 19, 1898 WHOLE No. 562

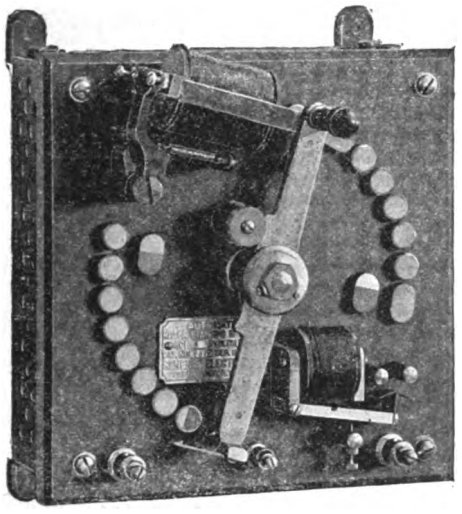

Fig. 4—Automatic Motor-starting Rheostat.

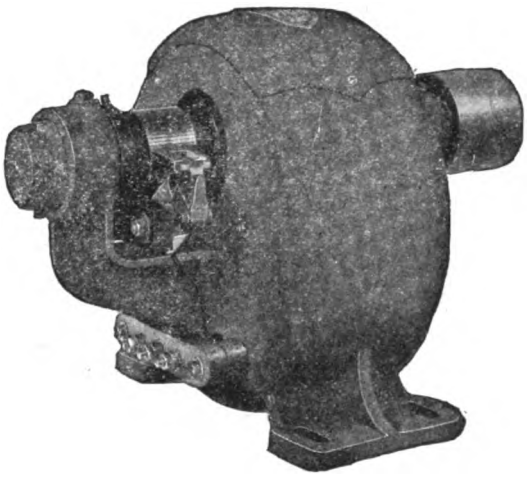

Fig. 1—Direct-current Station Motor, Type C. A, 1 H.P.

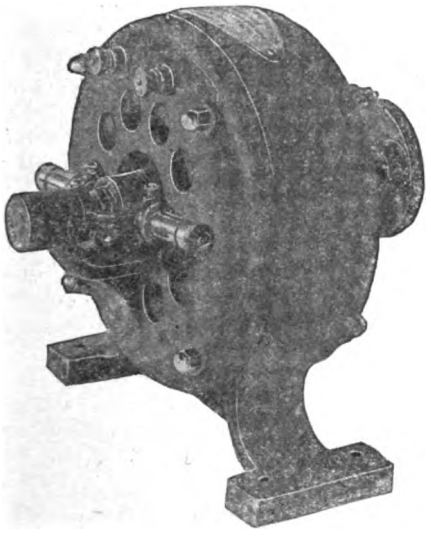

Fig. 3—Direct-current Station Motor, Type C. A, ⅛ H.P.

Fig 2—Direct-current Station Motor, Type C. A, ½ H.P.

GENERAL ELECTRIC MOTORS.

The General Electric Company announces in a recent bulletin a new line of well-designed and thoroughly constructed direct-current motors of small capacity adapted to the direct application of power to small machines of all kinds. They have been given the designation of "type A," and in their design the production of an efficient motor, sufficiently light and compact to allow of installation in cases where space is limited and absolutely rigid support is unobtainable, has been kept constantly in view. A magnetic circuit, therefore, entirely of laminated iron has been adopted, and greater lightness and compactness thus secured than would have been possible with cast iron. Furthermore, by the use of laminated iron a uniform magnetic circuit is ensured.

High grade material is used exclusively throughout these motors, and the workmanship is the best. The construction of the armature, commutator and field coils follows closely that in the standard General Electric railway motors. Indeed, every feature of excellence of the latter has been retained in the wound "C A" type. The laminated armature core is toothed and wound with the Eickemeyer type of coil. The leads from the armature are soldered directly into slots in the segments, and field coils are thoroughly taped and mounted on laminated pole-pieces. The armature can be withdrawn after taking off the pulley and bearing, and the field coils removed through an opening in the frame. In the larger machines the shaft is mounted on two similar swivel bearings each self-oiling. The brush-holders are adjustable radially, and may be revolved around the commutator if required. The neutral point is very wide, however, and no adjustment of the brush-holder is necessary. These motors are enclosed and thoroughly protected from mechanical injury, but thorough ventilation is provided by holes in the bottom of the case and around the commutator end of the armature. Should these motors be used in places where flying dust necessitates extra protection, the commutator and brush-holders may also be encased.

The speeds are lower than usual with motors of small capacity; better provision for overload is thus given and losses are not so great. The regulation, efficiency and disposition of the material in the "C A" motors also combine to give them a continued high economy. Heating tests show that they will run continuously with but slight increase in temperature, and even with a momentary overload of 100 per cent. little or no sparking is noticeable. In cases where a number of these motors are required to meet special conditions, the standard construction and wiring is susceptible of modification.

No rails are necessary with this motor. The belt is tightened by moving the motor on the lag screws, which pass through elongated holes in the feet of the frame and hold the motor in place.

One feature of advantage which this motor has over

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others is the possibility of placing it in almost any position with no greater change than the turning of the bearings to suit the position selected. The "C A" motor may be installed on the floor or be suspended from the ceiling, be set on a shelf or attached to a wall. In every case the oil cellar is at the bottom of the bearing.

The one H. P. and ½ H. P. C. A. motors are designed for 115, 230 and 500 volt circuits; the ⅛ H. P. for 115 volt circuits. The floor space for the first named is only 22⅞ inches by 16½ inches, and for the ½ H. P. motor 18¾ inches by 13 inches. The motors are finished in black with brush-holders and small parts nickeled and polished.

For use with the two larger sizes a new type of rheostat has been developed. It is provided with an automatic switch, which breaks the circuit in case of overload and effectually protects the motor armature. The smaller sizes are series wound and require no rheostat.

ELECTRICAL SHOW EXHIBITORS.

Electrical Age Publishing Co.,
World Bldg., Park Row, New York City.

Gentlemen: We beg to hand you herewith for publication a partial list of exhibitors who have contracted for space to date.

Would call your especial attention to the number of companies who have already secured space. This is over five times as many as we had secured at corresponding date before the last show.

Very truly yours,
Electrical Exhibition Company,
Marcus Nathan, Gen'l Mgr.

Partial List of Exhibitors, Electrical and Kindred Industries Exhibition, Madison Square Garden, New York, May 2d to 31st, 1898.

Armorite Interior Conduit Co.....Pittsburg, Pa.
American Rheostat Co.....Milwaukee, Wis.
American Electric Cold Supply Co.....Brooklyn, N. Y.
American Pulley Co.....Philadelphia, Pa.
American Watchman's Time Detector.234 Broadway, N. Y.
American Engine Co.....Bound Brook, N. J.
Adams-Bagnall Electric Co.....Cleveland, Ohio
Armington & Sims Co.....Providence, R. I.
American Electrician Co.....New York
American Elec'l & Maintenance Co.,
451–453 Greenwich street, N. Y.
American Electrical Works.....Providence, R. I.
Bullock Electric Co.....St. Paul Bldg., N. Y.
Bossert Electric Construction Co.....Utica, N. Y.
Baylis Co., The.....99 Cedar street, N. Y.
Bernard, E. G.....Troy, N. Y.
Borne, Scrymser Co.....80 South street, N. Y.
Belknap Motor Co.....Portland, Me.
Brewster Engineering Co.....27 Thames street, N. Y.
Crocker-Wheeler Electric Co..39 Cortlandt street, N. Y.
C. & C. Electric Co.....143 Liberty street, N. Y.
Corey, R. B.....26 Cortlandt street N. Y.
Coho & Co. H. B.,.....220 Broadway, N. Y.
Christensen Air Brake Co.....Milwaukee, Wis.
Card Electric Co.....Mansfield, Ohio
Cleveland Twist Drill Co.....Cleveland, Ohio
Crouse–Tremaine Carbon Co.....Fostoria, Ohio
Connecticut Telephone & Electric Co....Meriden, Conn.
Crown Woven Wire Brush Co.....Salem, Mass.
Cook's Sons, Adam.....313 West street, N. Y.
Campbell Underground Trolley Co.....Tonawanda, Pa.
Camp Co., H. B.....Aultman, Ohio
De La Vergne Refrigerator Co.
(Hornsby–Akroyd Oil Engine),
138th street & East River, N. Y.
Diamond Electric Co.....Peoria, Ill.
Diesel Motor Co. of America.....11 Broadway, N. Y.
Edison, Thomas A.....Orange, N. J.
Edison Electric Illuminating Co.,
Duane & Elm streets, N. Y.
Eddy Electric Mfg. Co.....Windsor, Conn.
Electric Storage Battery Co.....Philadelphia, Pa.
Excelsior Electric Co.....Brooklyn, N. Y.
Edison Mfg. Co.....Orange, N. J.
Edison, Jr., Thomas A.....96 Broadway, N. Y.
Electrical Engineer.....New York
Electrical Review.....New York
Electrical Age Publishing Co.....New York
Electricity Newspaper Co.....New York
Fisher Foundry & Machine Co.....Pittsburg, Pa.
Fort Wayne Electric Corporation.....Fort Wayne, Ind.
Fuel Economizer Co.....Matteawan, N. Y.
Fostoria Incandescent Lamp Co.....Fostoria, Ohio
Fiberite Co.....Mechanicsville, N. J.
Fairchild & Summer.....39 Cortlandt street, N. Y.
Gold Car Heating Co. ..Cliff & Frankfort streets, N. Y.
Harrison Safety Boiler Works,
Germantown Junction, Phila., Pa.
Highland Chemical Co.....Connellsville, Pa.
Haines Co., Wm. S.....Philadelphia, Pa.
Haring Steam Plant Equipment Co.,
26 Cortlandt street, N. Y.
Ideal Electric Corporation .13th & Hudson street, N. Y.
Imperial Porcelain Works.....Trenton, N. J.
India Rubber & Gutta Percha Insulating Co.,
Glenwood, N. Y.
Jones & Son, J.....69 Cortlandt street, N. Y.
Johnson Co., W. J.....New York
Keuffel & Esser Co.....127 Fulton street, N. Y.
Kelley & Sons, B. F.....91 Liberty street, N. Y.
Keystone Electrical Instrument Co....Philadelphia, Pa.
Lawrence Machine Co.....Lawrence, Mass.
Lewis Tool Co.....44 Barclay street, N. Y.
Lynn Incandescent.....Lynn, Mass.
Morris, Elmer P.....15 Cortlandt street, N. Y.
Machado & Roller.....203 Broadway, N. Y.
Mowrey & Co., P. M.....318 Broadway, N. Y.
Niles Tool Works Co.....Hamilton, O., and New York
National Meter Co.....118 Chambers street
Nowotny Electric Co.....Cincinnati, Ohio
National Carbon Co.....Cleveland, Ohio
Nash Gas Engine Co.....99 Cedar street, N. Y.
New Britain Machinery Co.....New Britain, Conn.
New York Safety Steam Power Co.,
30 Cortlandt street, N. Y.
Oswego Boiler Works.....Oswego, N. Y.
Otis Electric Co.....38 Park Row, N. Y.
Onondaga Dynamo Co .....Syracuse, N. Y.
Paragon Arc Lamp Co.....Boston, Mass.
Peru Electric Mfg. Co.....Peru, Ind.
Peckham Motor Truck & Wheel Co.,
26 Cortlandt street, N. Y.
Partrick, Carter & Wilkins.....Philadelphia, Pa.
Paragon Motor Co.....39 Cortlandt street, N. Y.
Porter & Remsen.....39 Cortlandt street, N. Y.
Roebling's Sons' Co., Jno. A.....Trenton, N. J.
Safety Insulated Wire & Cable Co.,
229 W. 28th street, N. Y.
Stephenson Co., Ltd., John ....47 E. 27th street, N. Y.
Silex Insulation Co.....39 Cortlandt street, N. Y.
Sprague Electric Co.....20 Broad street, N. Y.
Simonds Mfg. Co.....Pittsburgh, Pa.
Sinclair, D. J.....Caledonia, N. Y.
Street Railway Journal Co.....New York
Translucent Fabric Co.....Quincy, Mass.
Thomas & Sons, Co., R.....East Liverpool, Ohio
United States Electric & Supply Co.,
141 East 25th street, N. Y.
Vacuum Oil Co.,.....Rochester, N. Y.
Van Horne, Burger & Co.....Dayton, Ohio
Worthington, Henry R.....New York
Walker Co.....Cleveland, Ohio

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Weston Eleetrical Instrument Co.....Newark, N. J.
Warren Electric Mfg. Co.....Sandusky, Ohio
Williams & Co., J. H.....Brooklyn, N. Y.
Wendell & McDuffie.....26 Cortlandt street, N. Y.
White, J. G. & Co.....29 Broadway, N. Y.
Western Electrician.....Chicago and New York.
Worthington Water Tube Boiler..30 Cortlandt st., N. Y.
Zimdars & Hunt.....127 Fifth avenue, N. Y.

THE TELEPHONE.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

The Receiver.—The invention of the telephone has added greatly to the comforts of civilization by making communication rapid and easy and facilitating business transactions to an extent previously unattainable.

The simple principle of its action has been a source of surprise to the novitiate, and the ingenious methods by which it is possible to throw in and out subscriber after subscriber from a telephone switchboard is truly admirable.

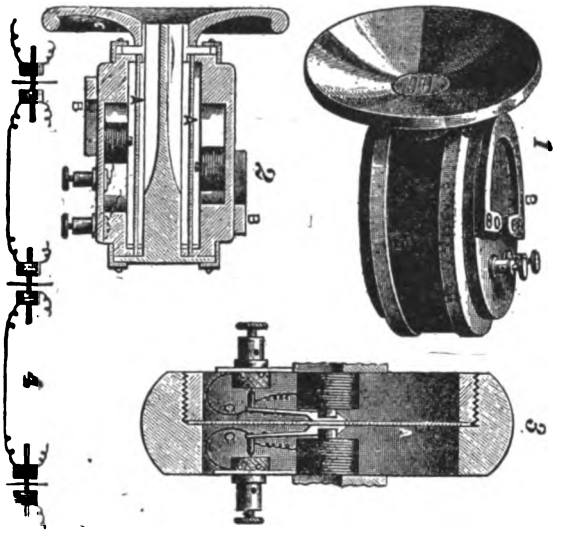
The vibrations of the voice striking the diaphragm are transmitted along the wire to the other receiver and there distinguished. The parts constituting a system are, therefore, the

Transmitter,
Receiver,
Line.

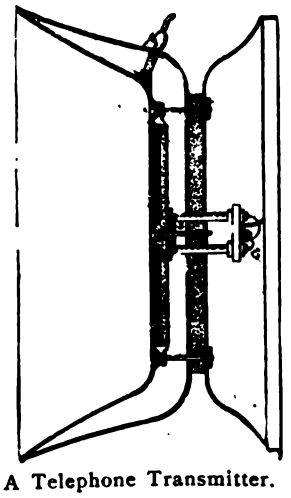
In the ordinary form of Bell telephone the parts composing the whole are three, namely:

Permanent magnet,
Coil of wire,
Diaphragm of iron.

The rod of magnetized steel is placed in a convenient receptacle and a coil of fine wire slipped on one end. The diaphragm is mounted in front in close proximity to the end of the magnet, and a mouth-piece placed so as to focus the sound on it. There is little difficulty in transmitting speech over several miles distance by such a system. In the practice of telephony the Bell telephone is simply used as a receiver for the sound and a somewhat different device used as a transmitter. Reference will be made to this shortly. The receiver, such as it has been described, depends for its action upon a very simple principle. The vibrating diaphragm disturbs the magnetization of the permanent magnet, as follows: When moving nearer to the magnet it increases the permeability of the field and in a corresponding manner decreases it when it moves away. The field is therefore varied in a corresponding manner, and to so definite an extent as to cause these changes to affect the coil surrounding the magnet. It may be stated at once as a fact



A Double Diaphragm on the Bell Principle.



A Telephone Transmitter.

The most prominent figure in the field of telephony is Graham Bell. After him follow the names of Berliner and Edison, as inventors of valuable additions to the original idea. A vibrating diaphragm is the basis of most acoustic instruments. The purely acoustic telephone consists of a piece of stretched membrane across a hollow drum with a cord or wire connecting both.

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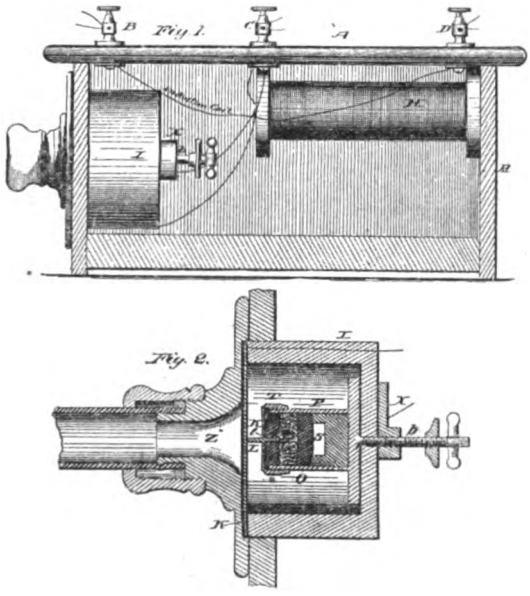
in science that the movement of a magnet in the neighborhood of a coil has an immediate effect upon it, developing an E.M.F. in its furns. This physical fact is the basis of the action in a telephone.

The vibrating diaphragm varies the magnetic field of the magnet, the coil placed on its end is at once affected and very small currents are set up in the convolutions.

The instrument at the other end is perfectly similar in construction and reproduces the vibrations again in its diaphragm, due to the fact that its coil connects with the other coil and all currents set up in the first at once affect the second, attracting and releasing its soft iron in perfect accord with the other.

There is in this simple principle the basis for an investment of twenty-five millions of dollars, which today represents the capital of the Bell Telephone Co. While the delicacy of the Bell receiver cannot be doubted, it is not effective over a long line.

De la Rue estimates the current as not exceeding that which would be produced by one Daniell's cell in a circuit of copper wire one-sixth of an inch in diameter, of a length sufficient to go 290 times around the earth.



Gillett's Granulated Carbon Transmitter.

Siemens, a distinguished electrician of Germany, does not think that more than $\frac{1}{10000}$ of the entire sound the transmitter receives is reproduced by the receiving instrument, and Roentgen concludes that no less than 24,000 currents are transmitted in one second by the instrument.

The extreme delicacy of the device employed needs no further discussion here, yet it is at times surpassed in this respect by the unequalled sensitiveness of the line itself to external influences of an electrical nature. The diaphragm can be dispensed with and a clear sound heard through the remaining parts.

This is simply cited as an experiment, not as the usual practice.

A rod of soft iron can be used instead of steel for the core of the coil. This necessitates the use of a battery in circuit, which would otherwise be dispensed with.

There is no doubt that the telephone is extraordinarily sensitive, and may be used for the detection of currents which would otherwise escape notice.

Contrary to the expectation of practical men the telephone works best with a diaphragm of ferrotype iron instead of very thin iron. The extreme susceptibility of the receiver places it in excellence far beyond any of the acoustic inventions of the age.

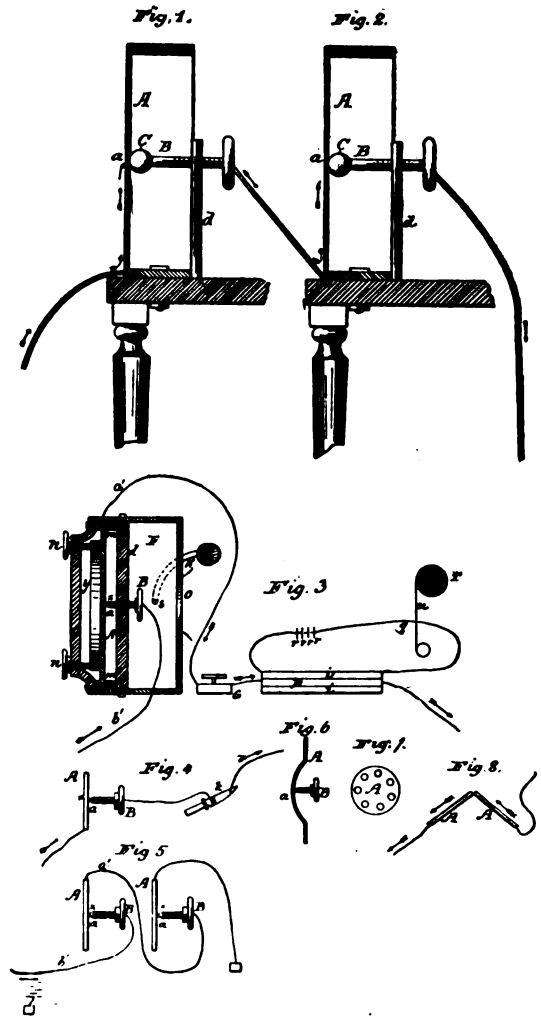
The Microphone.—Before explaining the details of construction of the modern transmitter it is necessary to understand the principle of the microphone, of which the transmitter is simply a development.

This peculiar piece of apparatus was invented by Prof. Hughes, and depends for its action upon the change of resistance in two pieces of carbon placed loosely in contact, and forming part of an electric circuit in which is included a Bell telephone receiver.

Two blocks of carbon are slightly hollowed out to receive between them an upright piece of carbon pointed at each end.

The Telephone and Line.

This is in circuit with a receiver and a battery. If the carbon attachment be mounted on a well-built sounding



Original Berliner Transmitter.

board, the least vibration affects it at once and causes the carbon pieces to jar together, causing a harsh, crushing sound to be heard in the telephone, greatly magnified, and giving the impression of a large body dragged over rough gravel. The ticking of a watch sounds like the heavy blows of a sledge-hammer, and the walking of a fly approaches in loudness the stamp of a horse.

The tap of a finger on the board, scratching of the nail or beating of the pulse, has been heard by means of this contrivance miles away. It is on this principle the transmitter of a telephone has been constructed, and its application is due to the combined efforts of Emile Berliner and Thomas A. Edison.

The compression of the carbon by these slight vibrations allows the current to increase or decrease an imperceptible amount. To the telephone, however, this minute change in resistance means a variation in current that at once produces the extraordinary effects above described.

Transmitter.—The wonderful delicacy of the microphone has therefore been the basis for the construction of a most easily affected piece of apparatus susceptible to sounds otherwise lost. It is, perhaps, the only apparatus by

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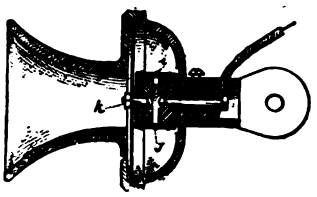
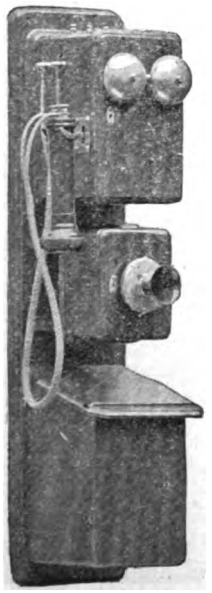


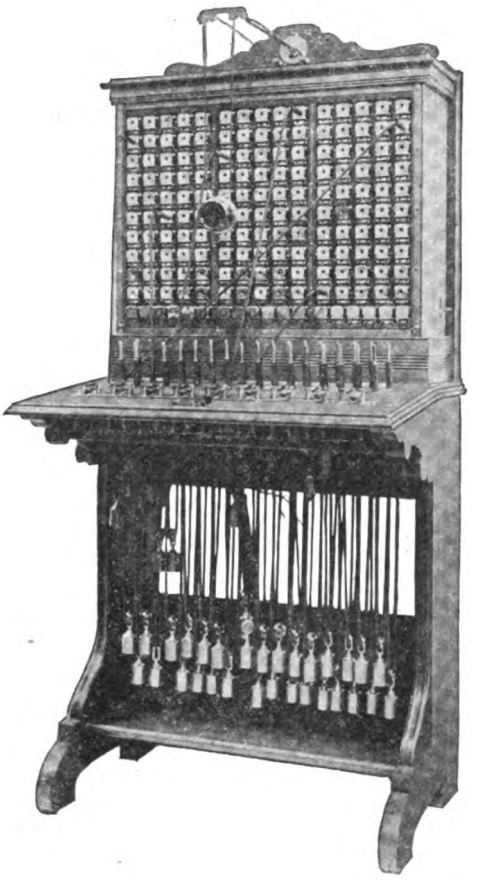
Sutton Microphone.

Transmitter.

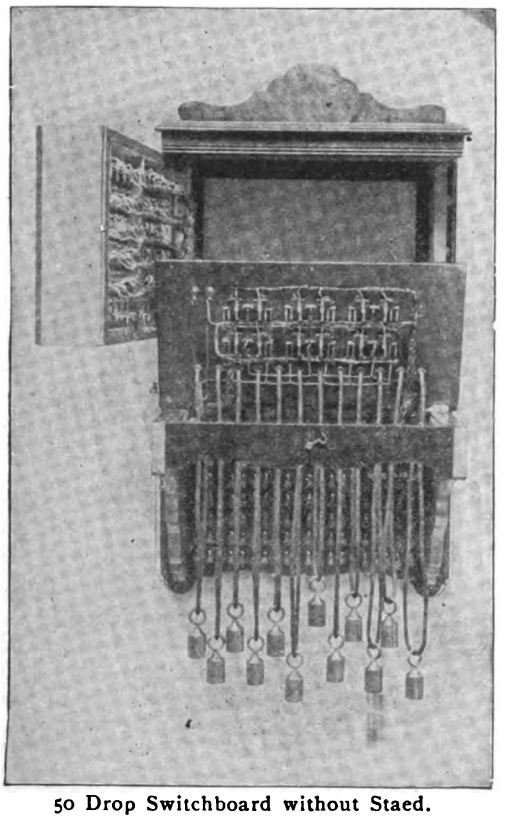
Desk Set.



Complete Telephone Outfit.

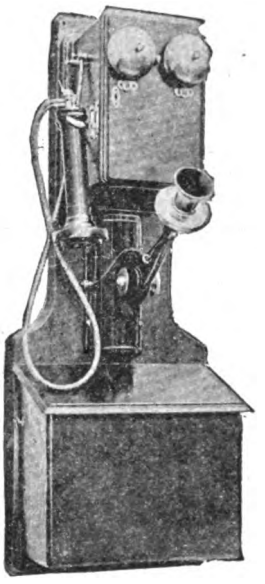


150 Drop Switchboard with Stand.
Self-restoring Drops.
Each Drop and Jack occupy a space of 1½ ins. square.

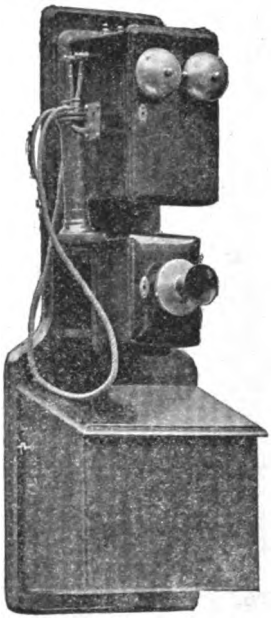


50 Drop Switchboard without Staed.
Thrown Back on Hinges, showing Jacks and Magnets.
Table thrown up. showing Switching Movements.

MODERN TELEPHONIC APPARATUS.



Regular City Outfit.



Transmitter, Receiver and Magneto.

Complete Telephone Outfit.

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which the voice could be heard over a long distance; and its ready application to telephone practice has been the means of saving the system from other than local use, allowing its extension over hundreds of miles—with the possibility in tne future of its further use for transatlantic communications.

The outgrowth of the transmitter from the microphone has been most effective in developing telephony to an extent otherwise inconceivable.

The transmitter, which renders speech clearer than any other piece of mechanism at the other end, is a direct duplication of the microphone. The sounding-board is not necessary, because the minute changes of current experienced by the transmitter at once affect the receiver and cause it to repeat acoustically and instantaneously the uttered sounds.

Principle of Transmitters.—The grating of the carbon pieces upon eaeh other varies the resistance of the contact. A decrease in resistance occurs when the carbons

Mianas Electric Company Ear-Piece.

are compressed and an increase to the normal status when the pressure is relaxed.

Many forms of telephone transmitters may be built on this basis. A contact which varies with the vibrations of the voice is the means by which a telephonic system may be constructed. The pieces whose resistance is supposed to vary and thus change the current need not necessarily be made of carbon. Many compounds have been used for this purpose of a metallic nature. The changes which occur and shake the enclosed particles are sufficient at times to pack or compress them to so great an extent as to render the transmitter insensitive to delicate vibrations and consequently useless for long distances. The varying contact and diaphragm are the subject of much thought by inventive minds.

The diaphragm sounds which fall ineffectively against the diaphragm are lost, and the timbre of the voice with them, for they constitute the distinguishing feature between voice and voice and the most characteristic tones of the ordinary speech.

The carbon contact may be in the form of a tube with a carbon block at each end. The tube is filled with granulated carbon and varies in resistance as the blocks at each end compress the particles within. As remarked before, the degeneration of the transmitter is heralded from the time the carbon begins to pack. Alloys of high resistance metals have been used ground into powder with no success.

Diaphragms made up of laminæ have appeared on the market, but the delicacy of the instrument has not appreciably increased by their use over a long line, and the overtones do not leave their impression on the receiver. A large transmitter is equally ineffective and impracticable, by conveying the sound in greater volume but with corresponding deficiencies in tone and evenness.

Carbon Button.—The carbon button upon which Edison's invention rests is attached to a strip of metal, and the vibrations of the diaphragm reach it through the medium of a double-pointed attachment touching the diaphragm and the button. In circuit with the transmitter is a battery and coil of wire. When the transmitter is used, the changes of current vary the magnetism of the coil by increasing and decreasing it. A coil of fine wire wound around the first responds to these changes and sends the minute pulsations over the line to which it is connected.

Lines.—Lines are made either of copper or iron. The usefulness of a line as an efficient means of communication between two distant points depends upon its conductivity and insulation; with good insulation and bad conductivity, or poor insulation and excellent conductivity the fault is equally reprehensible.

A relation between the conductivity of the line and its insulation resistance should exist and, if possible, be preserved in practice.

Long lines for either telegraphic or telephonic purposes are necessarily subjected to more leakage, because of the increased number of poles, than short lines. Yet short lines may be very defective, having high resistance in themselves and a character of insulation which compels criticism. Long lines have their insulation pulled down because the many glass insulators to which they are attached each allow a slight leakage to occur and thus in total create quite a flow of electricity to the earth. A relay at the end of a telegraphic line in such a case may be affected or lose its sensitiveness, and a telephone system fall in many respects, by leaving itself open to accident from other power-bearing lines in the vicinity.

QUESTIONS FOR REVIEW.

(1) What is a receiver?
(2) Of what does a telephonic system consist?
(3) How many parts are there to a Bell telephone?
(4) What is a microphone?
(5) Upon what principle is a transmitter constructed?
(6) Why is leakage present in a long line to a noticeable degree?

OBERG & BLUMBERG.

We beg to advise you that we have severed our connections with the Alexander-Chamberlain Electric Co., and have opened offices at No. 853 Broadway (corner 14th street, with full facilities for executing contracts for electrical work of every description.

Trusting that you will favor us with the opportunity of figuring on any work that you may have at your command, we are,

Respectfully yours,
Oberg & Blumberg.

Winnsboro, Tex.—W. G. Ragley Lumber Company may give information concerning establishment of electric light plant.

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The Electrical Age.

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COOKING AND HEATING BY GAS AND ELECTRICITY.

The opinion of the public on the subject of electricity and gas for heating and cooking is certainly one that cannot be dispensed with because of the fact that they unconsciously institute a demand for these things and certainly aid the sale of apparatus used by their application. In Manchester, England, the Northern Society of Electical Engineers held a meeting January 24th. A paper was read by Mr. W. P. Adams, called "A Survey of the possibilities of Electric Cooking and Heating." His opinions in relation to the above subject were unique and interesting. A belief was expressed by him that electricity would soon be used more for heating than for lighting. He admitted that the higher efficiency and cleanliness of electrical apparatus used for culinary purposes placed it on a higher plane than such types as burnt gas. He gave some figures relating to the cost of both electricity and gas when used for cooking. The case referred to was one in which the household consisted of five people and the expense respectively of gas and electricity was, according to his figures, $1.25 per week for electricity and only .92 for gas. It seems, however, that his conclusions were not accepted with any degree of satisfaction by manufacturers of electric heating apparatus, and we include within this editorial the opinion of one that begs to disagree:

"As a member of a firm who are manufacturers of electrical heating appliances, and naturally interested in their success, I feel sure that such statements as those of Mr. Adams can only injure and disgrace an industry which fills well a certain limited space. In the infancy of the gas-heating appliance trade, the same method of exaggeration was carried on, but not to a tithe of the extent. Such as it was, it discredited the whole industry, and created an army of unbelievers who acted as a drag on it for many years. It is to be hoped that history will not repeat itself as regards electrical heating.

"I believe that one electrical unit is equal to 1,000 watt hours, or 3,440 British thermal units, which latter is equal to the heating power of 5 cubic feet of coal gas. 1,620 thermal units will, in theory, raise 1 gallon of water from 50° to 212° F.; in practice, with gas, in small kettles, double this is required. Taking gas at 60 cents per 1,000 cubic feet, the cost of this is 2 cents for 6 gallons. If all the electrical energy is used and no waste occurs (a practical impossibility), at the usual 10 cents per Board of Trade unit, it will cost 31 cents to boil 6 gallons of water. It would appear that Mr. Adams ignores the water-heating in the electrical arrangement, as the total current expended would not heat half the water required, to say nothing of any cooking. Allowing for one-half the gas being wasted, 300 cubic feet would do the same work as the $1.25 worth of electricity (at 4 cents per unit) if none of the latter were wasted, which is impossible; and in addition to the 150 cubic feet of gas allowed for waste, another 940 cubic feet must have been thrown away if Mr. Adams' figures are correct. It would be interesting to know the retail cost of a complete electrical cooking apparatus which would do the work of the gas cooking ranges hired out by the gas companies at a few shillings per annum, say one capable of cooking a complete dinner for ten persons; also the average cost per annum for repairs and renewals, and who is to be paid for these."

The reader may judge, from the nature of this communication, whether such sentiments are not free from bias and the figures contained in the above nearer to the mark than those put forth by Mr. Adams. As a nation of progressive men we can certainly feel assured of the fact that, despite the trials and tribulations that electric heater men and salesmen of electric cooking apparatus may pass through in introducing their goods; they will, in the end, triumph over the prejudices inspired by those whose interests lie in an opposite direction. Electric heating and cooking will be universal when the cost of electricity brings it into the home of the poor as well as the middle class. It is so safe, clean and economical that there is hardly any doubt of its ultimate success. The public believe electric heating to be the *ne plus ultra* of any known method, and as the future of its broader introduction rests with them, manufacturers of these goods can feel confident that ultimately their sale will be rapid and extensive.

FUN WITH THE UNDER TROLLEY.

The small boy of this town has discovered that there are possibilities for fun in the new under trolley conduits of the street car roads, just as he found the cable roads a source of illegitimate pleasure when they were first built. He can't get a free ride or set kites flying down the lines as he did on the cable roads, but he has found that the under trolley conduits contain no end of means for producing electrical fireworks.

One small boy was seen the other day poking a tin toy sword down into the slot. Presently he succeeded in bending the end of the sword so that it made a connection from one current-bearing rail below to the other, and then there came a snapping and crackling, accompanied by a great flash of colored light. Part of the current ran up the sword and gave the boy's arm a wrench. He dropped the sword with a yell and went scudding away with a scared expression on his face.

Other boys have taken to dropping bits of wire into the slot. When a piece of wire falls so that it touches both electric rails at the same time there is a great flash of light as the current darts across the wire from one rail to the other. When such a thing happens, a man in the power-house knows it at once, for at that moment one of

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the automatic circuit breakers which he watches pops out with a bang, and if it is at night the lights on the cars go out. The watcher pops the circuit breaker back and everything is all right again.

It is not safe for the boys to play with the electric currents passing through the hidden rails, for they might easily get a serious shock and burns. A story comes from the West which may not be true, but is possible, and illustrates the danger of fooling with the electric currents. This story relates to a long line over which a current of 20,000 volts is passed. The line has two copper wires, one for the positive and the other for the return. The two wires are carried on poles, side by side, and not very far apart. One day the line broke and the repair men found both wires melted in two at the same point. From the indications formed the men decided that the trouble had been caused by the quarrel of two eagles. One eagle had lit upon one of the wires and the other had lit opposite him on the other wire. As long as they sat thus apart no harm came to them, but they first looked askance at each other and then struck at each other with their beaks. The moment the beaks came in contact there was a flash of lightning, a puff of smoke, and the main part of the eagles vanished and the wires melted. What led to this theory was the fact that directly under where the wires were melted were enough claws and eagle feathers to indicate that the two birds had been on the wires.—Ex.

A PERSONAL EXHIBIT BY PROF. S. H. SHORT.

In addition to the superb exhibit which will be made of all its modern apparatus for the generation and use of electricity by the Walker Co., of Cleveland, Prof. S. H. Short, its electrical engineer, well known as one of the most distinguished and successful pioneers in the electric railway field, will make a personal exhibit. For some fifteen years Prof. Short has been actively engaged in railway design and invention, and as far back as 1885 organized a company in Denver, which laid and operated a slotted conduit railway. His work will now be interestingly and richly illustrated by pictures, relics, models, old apparatus, etc., and will constitute one of the features of the show and will attract wide attention and help secure for Prof. Short the recognition which certainly is his due.

INVENTION OF LAMPS.

The invention of lamps is ascribed to the Egyptians. In the British Museum are two colored glazed tiles which were fixed in the centre of the ceiling; each has a large knob pierced through the base to receive a cord for suspending a lamp; around the base of each is an inscription stating that it formed part of the decoration of the Temple of Kammuri at Calah Nimrod in the time of Assuru-Abla, 885 B. C. What the lamps were made of cannot now be ascertained, but there is plenty of contemporaneous glass which has been discovered in the neighborhood.

The sacred lamps in Greek temples, whose undying flames were perpetually watched by vestas, were probably of metal, and the wick formed of asbestos.

In the public baths at Pompeii two lamps were used, each to light two rooms. These lamps were protected by circular convex glasses, fragments of which were found on the spot.

The marvellous accounts by mediæval authors of perpetually burning lamps found in ancient tombs seem too numerous and too well attested to be altogether fabulous. When the tomb of Pallas, son of Evander, who is mentioned by Virgil, was discovered about the 12th century by a countryman digging near Rome, it is said a lighted lamp was still burning over his head, which must have been lighted more than 2,000 years, and might be called eternal.

Baptista Porta, in his treatise on Natural Magic, relates that about 1550 a marble sepulchre of the Roman period was discovered in an island near Naples, and on opening the tomb was found a phial containing a burning lamp. This light became extinct on breaking the phial and exposing the flame to the open air. It was supposed that this lamp had been concealed before the Christian era, and those who saw it reported that the lamp emitted a splendid flame.

In 1550 a remarkable lamp was found near Atestes, Padua, by a rustic digging, who unearthed a terra-cotta urn containing another urn, in which was a lamp placed between two cylindrical vessels, one of gold and the other silver, each of which was full of a very pure liquid, by whose virtue the lamp had been kept shining upward of 1,500 years. This curious lamp was not meant to scare away evil spirits from a tomb, but was an attempt to perpetuate the profound knowledge of Maximus Olybius, who effected this wonder by his extraordinary skill in chemical art.

St. Augustine says a lamp was found in the Temple of Venus, exposed always to the open weather, and which could never be extinguished. Ludovicus Fives mentions another lamp, which was found a little before his time, that had continued burning for 1,050 years.

Licetus is of the opinion that the perpetuity of these lamps was owing to the consummate tenacity of the unctuous matter with which the flame was united being so proportioned to the strength of the fire that, like the radical heat and natural moisture in animals, neither of them could conquer or destroy the other. In order to preserve this equality of proportion these lamps were hid in caverns or closed monuments. On opening these tombs, the admission of fresh air has produced so great an inequality between the flame and the oil that they have become extinguished. In Henry VIII's time a lamp was found in a monastic tomb that had been burning for 1,200 years.—The World of Progress.

PORTABLE ELEVATORS AND RACKS.

(Patented May 22, 1894.)

Live and learn is a very old adage. The last three or four years have taught us that we have to fight to live, but the strain of the battle is greatly mitigated by having our eyes ever open and our minds receptive for new methods of economy. The warehouseman, wholesale grocer, wine association, glucose manufacturer, molasses manufacturer, hotel man, brewer and a host of lesser lights straining for the almighty dollar, while only making a scant profit of the small savings accruing by economy, are not wasting time by giving careful study to the improved methods offered for racking goods, and learning what there is to be said on the subject. The old dunnage system has been in vogue for a long time and millions of feet of lumber have been purchased to form the runner, on which successive tiers of barrels rest, later to be knocked about here and there, seared, broken or lost, as the case may be, never at hand when wanted and always in the way when not wanted, a source of constant expense and worriment; are we never to get a more improved method? The Dunnage system requiring care, expense of handling and limited tiering shall we keep it for old friendship's sake? The leaking, weeping barrel of glucose, whiskey, wine or molasses groans under a weight of two or three tiers and absolutely refuses to sustain a greater weight on its sides, thus leaving many cubic feet of space above to be filled by the atmosphere. But even with the burdens put upon it by man the barrel will weep at times, and its tears must be quenched, otherwise it will waste itself away. The easy-going companions on the top tiers must be removed one by one until the sufferer can be reached and its open sides treated by the cooper's surgery. But this is expensive; is there not a way for doing away with all this? The pork barrel has its vulnerable points, and

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has to be turned from time to time or rust will work havoc. Inconvenience, excessive cost for handling, partial use of storage room, leakage, etc., are all drawbacks of the dunnage system, and the question is, can they be wholly or partially bettered, and that with small investment?

Old Method.

The Fox Elevator & Rack Company, 120 Liberty street, New York City, offers a new system which has been tried by some of the largest companies and has their endorsement. The rack is self-contained, needing neither nails nor screws, being made up of timber spaced by iron spacers and bound together by steel bolts. They can be made of any size and put up or taken down in a very short space of time, by the use of wrenches, in the hands of a common laborer. These racks can be built from floor to ceiling, thus giving maximum capacity, and of any width, although it is often advisable not to have them over two barrels wide so as to allow of thorough inspection. The barrels are rolled in place, each tier separate from the one above and below, and every barrel having simply to sustain its own weight, thus reducing leakage to a minimum. Should cooperage, however, be needed, only one tier at the most would have to be removed. The labor item is greatly reduced by the use of the portable elevator, as only two men are needed instead of three, not to speak of the saving of tearing down and putting up when leakage occurs.

The elevator is of very simple construction, good for years of hard usage without cost of repair. It runs very easily on the floor and when placed in front of any particular rack one man can easily raise a barrel to the height required, when it is rolled on the rack. By means of one lever he can free the ratchet on the elevator, and by a second lever control the drop of the platform. While it is true that this system is patented—patented appliances usually are expensive—the company can easily demonstrate that they can install their system at a less cost than for home-made fixed racks, and, besides, give to their customers an article that can be valued on the books—which cannot be said of fixed racks, as the law makes them the property of the owner of the building. The cuts are reproduced from photographs taken from actual working conditions.

New Method.

New York, N. Y.—Steps are being taken to build an electric railroad from Philadelphia to Jersey City.

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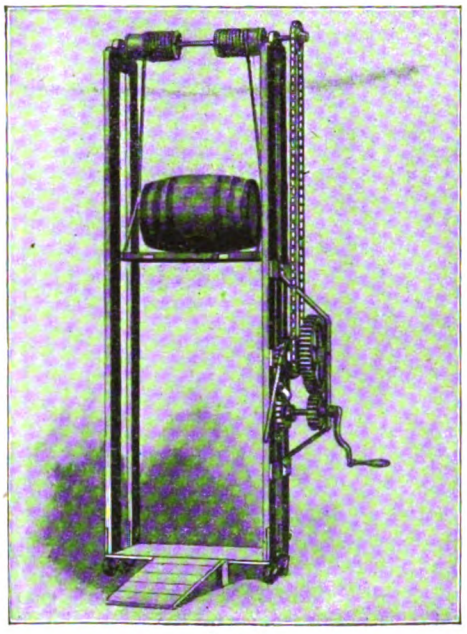
AMERICAN COMPETITION IN EUROPE.

(Continued from page 94.)

Another expert, who has travelled through the Atlantic States to find the secret of the superior quality and cheapness of American factory-made shoes, brings back the surprising statement that, in a certain Massachusetts shoe factory which he visited, the average wage earned by all classes of operatives was $15 per week, and the net labor cost per pair of shoes produced 40 cents, whereas in German shoe factories, where the average earnings of operatives are only 16 marks ($3.80) per week, the labor cost for shoes of similar grade is 58 cents per pair. Facts like these have produced, during the past year, a noticeable change in the attitude of technical journals and the more intelligent European manufacturers toward the growing danger from beyond the sea.



Elevator.

Hitherto they have found it comparatively easy to persuade themselves that, but for the American tariff, which could be only a temporary measure, the United States might be held permanently to its function of growing food and raw materials for European operatives and manufacturers who would supply the world, our own country included, with manufactured products. But it is now seen that it is something besides tariff that has made the cost of producing Bessemer pig iron 10s. to 15s. ($2.43 to $3.65) per ton less in the United States than Great Britain, has enabled the steel makers of Pennsylvania to underbid those of England for the rails and other supplies of the London Underground Railway, and to place an order for 8,000 tons of steel rails with the British East Indian Government. Neither has any trick of fiscal legislation enabled the machinists of Philadelphia, Pittsburg and Chicago to sell locomotives, mining and electrical machinery, street-railway outfits, bridges, and architectural iron under the noses of British, German and Belgian agents in South America, Australia, and the Cape of Good Hope.

Three years ago German manufacturers honestly believed that, but for the import duty, they and their English rivals could monopolize the American market for bicycles and sewing machines. Since then the American-made bicycle has invaded successfully every important European market, and not only in quality, but in price, has made the competition in Germany so keen that the local makers now demand the imposition of a special high duty on American wheels as essential to their future existence. The steel-bridge builders of Belgium and Great Britain have been surprised to find themselves underbid for the construction of an important bridge in Holland by a company in Philadelphia, and the leading makers of electrical machinery in the United States have set a standard of cheapness, prompt delivery, efficiency and economy of service, especially in electrical railway plants, with which their European rivals find it difficult to compete.

It is but natural that, these facts once recognized, the utmost use should be made of them in these older countries as arguments in favor of concessions and privileges which have hitherto been generally withheld. Throughout the prolonged strike of machinists in England, the most effective plea of the employers has been that without the concessions that they demand from their employees, future competition with American engineers will be impossible, and the supremacy of Great Britain in that field irretrievably lost. In Vienna the Imperial Minister of Foreign Affairs has called upon all Europe to combine against what he calls "the crushing competition of transatlantic nations." At Berlin, a council of specialists has been recently in session to consider international tariff relations, with special reference to Great Britain and the United States. German economists point to the 18,000,000 tons of freight which pass annually through the single lock at the Sault Ste. Marie Canal as an argument in favor of the further improvement and extension of German waterways, and to the unexampled economy and efficiency of American railway freights as an appeal against the inert, exorbitant rates of the State railroads in Germany. Said director Schrodter at the convention of iron and steel producers at Cologne:

"The German iron and steel industry may claim that, in respect to technical capacity, it is not behind that of the great American plants, and as we must not resort to wage reduction, except in the last extremity, the only means of relief is in lower freights. Without substantial help by this means, the German iron and steel industry will not much longer be able to maintain its export trade as it at present exists, much less to increase it."

Expert officials have been sent over to study the construction, equipment, and manangement of American railroads, and the result thus far has been the 60-feet-long vestibule passenger car, mounted on pinion trucks; but the old four-wheeled, 10-ton freight car still maintains its placid sway.

It is not improbable that these appeals will have, in the near future, a more or less important effect. Already,

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the freight rates for ship-building materials on the State railways between Westphalia and the shipyards of Stettin, Hamburg and other coast cities have been greatly reduced, and important improvements in the water route from Berlin to Stettin and the projected waterway from Berlin to Rostock via the Mecklenburg lakes are movements in the same direction.

(To be continued.)

EXTRACT OF ARTICLE ON SPARKING.

By Thorburn Reid.

Now consider how the current should vary during the period of commutation, so that the energy of commutation will be developed equally over every part of the contact surface, and so that the amount of energy developed shall be a minimum.

First consider the variation of the current which will satisfy the first of these conditions. This condition will be fulfilled if the current density in every section remains constant as long as the area of contact is changing; for every part of the segment remains in contact with the brush for the same length of time, that is, the time required for that part to pass from the heel to the toe of the brush. Therefore, since every part is receiving energy at the same rate and for the same length of time, the energy developed in each part is equal. While the whole segment is covered, any change in the current density will affect every section equally, so that the current may vary in any way during that period, without causing unequal distribution of energy.

Consider how the current should change so as to develop the least energy. That is, how the current must be distributed between the contact surface of the segments so as to develop the least possible amount of energy.

Let R_1 and R_2 be the resistance of the two segments, and C_1 and C_2 the corresponding currents, C being the total current flowing. Then we have for the rate at which energy is being developed at any period:

$$W = C_1^2 R_1 + (C - C_1)^2 R_2 \qquad (1)$$

Differentiating and equating to zero, we have

$$C_1 = \frac{R_2}{R_1 + R_2} C \qquad (2)$$

To determine whether this gives a maximum or minimum value, substitute in equation (1) for C_1 the values $C = 0$ and $C_1 = C$ and we get for $C_1 = 0$, $W = C^2 R_2$ and for $C_1 = C$, $W = C_2 R$. Both these values are higher than that obtained by substituting from equation (2) in equation (1), namely:

$$W = \frac{R_1 R_2}{R_1 + R_2} C_2$$

Therefore that value of C_1 makes W a minimum.

This means that for each position of the brush, the energy developed at the contact surface will be a minimum when the current divides between the segments under the brush in the ratio of their areas of contact. It is seen that under these conditions, the current density remains constant, and that therefore the requirements of equal distribution of energy are also fulfilled.

Perfect commutation may now be defined as a complete reversal of the current in the coil under commutation, in such a manner that the portions of the current flowing through the two segments to which ends of the coil are connected shall be proportional to the respective contact areas of the segments.

It was shown above that $C_2 R_2 = C_1 R_1 + CR$ drop in the coil plus the inductance E in the coil plus the reversal E. If, therefore, the sum of the CR drop of the coil plus its inductance E were always equal and opposite to the reversal E, $C_1 R_1$ would be equal to $C_2 R_2$, which is the condition for perfect commutation as defined above.

To sum up, the deleterious effects of sparking are due to excessive local heating of the commutator contact surface, causing the copper to melt, and an arc to be drawn, the segments being thus disintegrated.

The causes of deleterious sparking are either too great a departure from perfect commutation, or too high a current density.

Perfect commutation can only be practically secured by making the impedance of the coil negligible as compared with the contact resistance. A comparison of the sparking constants of a large number of machines was made before this theory of commutation was evolved.

It has been found to explain many cases of sparking which had before been unexplained.

It has been found difficult to determine definite safe working constants, on account of the small number of tests that have been made to determine accurately the inductance of the coil under commutation and the effect on each other of two or more coils commutating at the same time.

NOTES.

Orlando, Fla.—B. C. Abernathy and others will probably construct an electric light plant.

Waukegan, Ill.—The Bluff City Electric Railway will resume construction.

Atlanta, Ga.—The Atlanta Water Power Company applied for charter, with Henry B. Wilson, Emerson McMillan, R. H. Smith and C. Emerson, to manufacture electricity, etc. The company has options on lands valued at $175,000, including three shoals, which will develop 11,000 horse-power.

Toccoa, Ga.—The Toccoa Telephone Company has been incorporated by John McJunkin, C. H. Dance, L. P. Cook and others, for constructing and operating telephone systems. Capital stock, $5,000.

New Orleans, La.—The People's Telephone Company will construct and operate a telephone system, the wires of which are to be laid underground in conduits.

Elkin, N. C.—The Elkin Electric Light and Power Company has been incorporated by Alex. M. Smith, Gilvin T. Roth, and Hugh G. Cheatham, for erecting and operating an electric light and power system. Capital stock, $2,000.

Knoxville, Tenn.—The Knoxville Street Railway Company will make improvements to its electric power house and railway, etc.

Beaumont, Tex.—The Southwestern Telephone and Telegraph Company has been granted franchise, and will establish a telephone system and exchange.

Washington, D. C.—The Capital Traction Company has obtained permission to make several extensions to its electric line in the city.

Baltimore, Md.—The Consolidated Railroad Company has decided to construct several extensions of its electric lines on Schroeder street, and in the southwestern suburbs.

Gatesville, Tex.—Gatesville Electric Light Company is reported to have asked for receiver.

Baxter Springs, Kan.—The Baxter Springs Light and Power Company is succeeded by the Metropolitan Light and Power Company.

Rock Rapids, Iowa.—An electric lighting system has just been completed.

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Chicago, Ill.—Fischer Equipment Company has been incorporated by Andrew J. Hirschi, William A. Rogan, Edgar R. Hart, to supply electrical equipment. Capital stock, $2,400.

Wallace, Idaho.—The Montana Telephone lines are to be extended to this city, which will give a through line to Oregon and California.

Greenville, Mich.—Greenville Telephone Exchange has been incorporated with a capital stock of $15,000.

Dickson, Tenn.—Captain John Adams may be addressed concerning establishment of an electric lighting plant.

Marion, N. C.—J. W. Kirby and B. B. Price will put in a telephone system for Marion.

Seymour, Tex.—The Haskell and Throckmorton Telegraph and Telephone Company has been incorporated by T. H. C. Peery, G. P. Barber and G. C. Plants, to construct, operate and maintain a public telegraph and telephone line and system between the towns of Seymour and Haskell. Capital stock, $3,000.

Ventura, Cal.—The Ventura Land and Power Company plant was destroyed by fire; fully insured.

Lexington Va.—A bill has been introduced in the Legislature at Richmond, applying for a charter for the building of an electric street railway in this city. J. R. Williams and Augustine Royall, of Richmond, are interested.

Chicago, Ill.—Calkas Light Manufacturing Company has been incorporated by Edward J. Ryan, Henry C. Marston, Thomas D. Shannon, to manufacture lamps and lighting appliances. Capital stock, $100,000.

New York, N. Y.—Bernstein Electric Company, of Boston, attachment issued against them from Steuben County, N. Y., for $1,459 in favor of the Corning Glass Works.

Missoula, Mont.—The Rocky Mountain Bell Telephone Company manager has been ordered to extend line to Wallace, Idaho.

Springfield, Ill.—The Chicago and Desplaines Valley Electric Railway Company has been incorporated by Henry G. Foreman, Clayton E. Crafts, Charles D. Evans, Philip H. Gray and William M. Hulbert, to construct and operate an electric railway from a point in the town of Wheeling to some point in the town of Lemont. Capital stock, $1,000,000.

Hagerstown, Md.—The Washington County Electric Power Company are preparing articles of incorporation, for the purpose of establishing an electric plant in this city, to compete with the plant owned by Powell Evans, who is negotiating with Williamsport, Pa., capitalists for the sale of his plant. Evans has the contract to light Hagerstown until 1901.

ELECTRIC FIRES.

F. H. Wentworth is of the opinion that many cities are so slack in their methods of controlling their systems of wiring that it is only by sheer luck that there are not twice as many electrical fires as are on record. When an outside overhead wire, carrying current of either high or low potential, comes in contact with an ordinary signal wire, the latter, in case of poor or defective insulation, is immediately charged with the heavy current, and carries it into any building into which it happens to run. Fires from this cause are of daily occurrence and are responsible for over one-seventh of the annual electrical fire destruction.

Mr. Wentworth maintains that one source of this trouble is the cheap, incompetent hands which, under the name of electricians, are intrusted with details of an installation which require both skill and experience. For instance, most fuses are made of soft metals, principally lead and tin, in the proportion of three to one, making a composition which melts at a temperature of less than 300 centigrades. Copper requires a temperature of over 1,000 degrees before it will melt. Mr. Wentworth says: "I frequently find copper wire in fuse boxes put there by men whom their employers call electricians. This is analogous to hanging a millstone on the safety-valve of a steam boiler. A never-failing way to correctly estimate the intelligence of the man in charge of an electrical equipment is to examine his cut-outs and fuse boxes. If they are manifestly overfused, or contain copper wire, he may be set down as either grossly careless or lamentably ignorant. Flexible cord used as line wires in lighting show windows is a constant source of fire, and it is tempting Providence to wrap up incandescent lamps in cloth, cotton, straw and every variety of inflammable material as some storekeepers do in decorating their windows. Merchants hang arc lamps without spark arresters immediately over inflammable goods, and see the hot particles of copper and carbon thrown off by the arc with no appreciation of the danger. Wires are run on pipes, structural iron work, metal columns and other conductors and in this department of electrical work there is a great deal of practice which is slovenly and dangerous."

Mr. Wentworth cites these facts for the purpose of impressing upon every municipality that it should provide for a rigorous inspection wherever electricity is used in any form.—The Tradesman.

THE CENTRALIZATION OF POWER STATIONS.

The future tendency of electrical engineering is toward the centralization of power stations. It will pay, in a very large city, to erect a single station where coal and water can be had the cheapest, and generate current there on the high-pressure basis, 6,000 or 7,000 volts being about the figure demanded by the present state of the science. Then, send the small current to the stations now used as power houses, and there transform the high tension small current into that called for by the service it has to meet.

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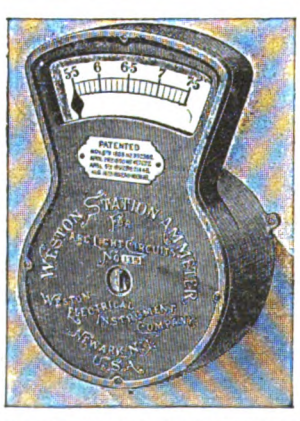

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are reminded that the next quarterly issue of the TELEPHONE DIRECTORY will go to press on March 1st. To obtain the advantage of listing in this issue of the directory it will be necessary to make contracts during the present month.

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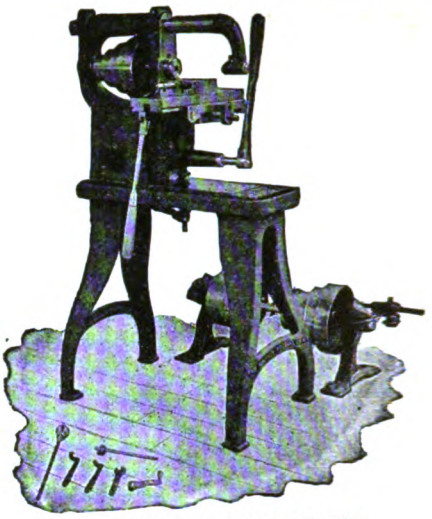

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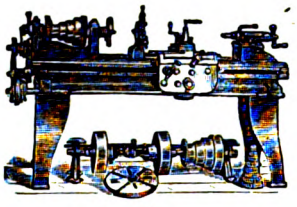

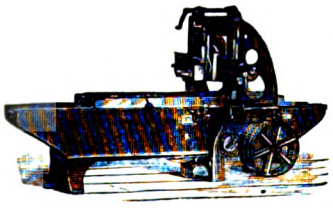

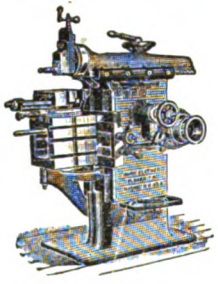

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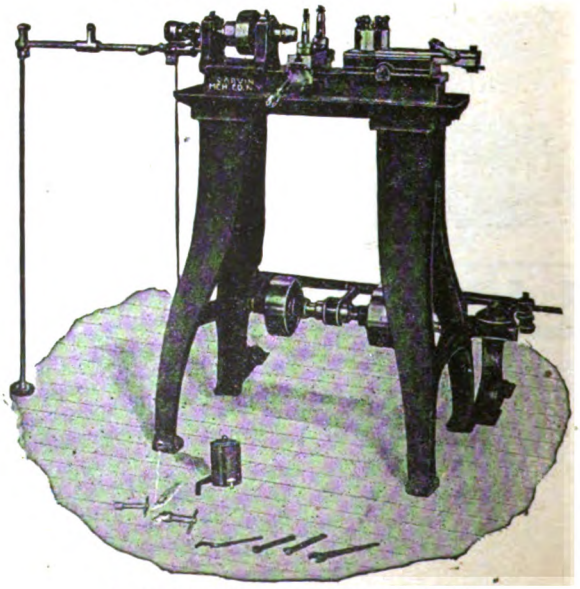

No. 00 SCREW MACHINE (WIRE FEED).

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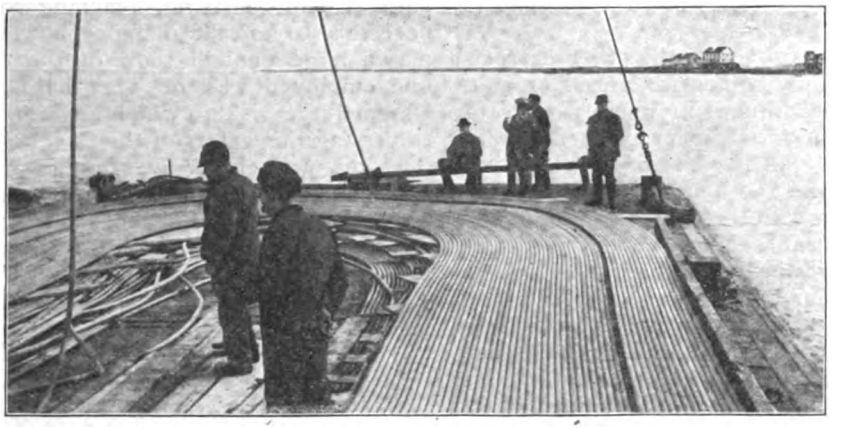
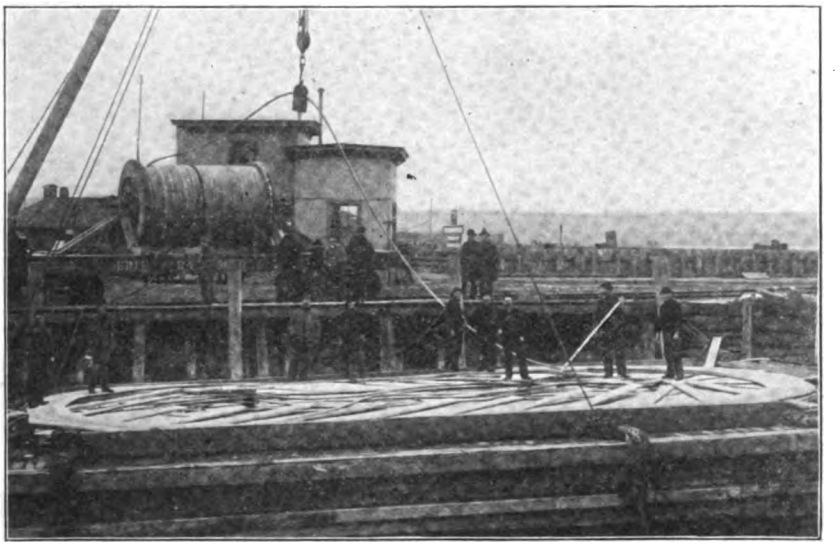
The Electrical Age.

VOL. XXI—No. 9 NEW YORK, FEBRUARY 26, 1898 WHOLE No. 563



Paying Out the Cable Across Great South Bay.



Transferring the Cable from the Reels to the Deck of the Wrecking Scow.

THE LAYING OF A SUBMARINE CABLE.

Landing the Shore End of the Cable at Fire Island.

According to the report of the International Bureau of Telegraph Administration, received in 1890, at least 120,070 nautical miles of submarine cable are in actual use. Of this mileage at least 100,000 is the property of private corporations; the balance belongs to the government, or some company connected with them in an administrative capacity. In 1890, the estimated value of the cables in use reached the figure of $200,000,000. The public well appreciate the advantage of having the globe encircled with a belt of electric cables. News is instantly flashed from point to point thousands of miles apart and the distant Transvaal is as near to us, telegraphically, as the shore of Coney Island, or the Capitol at Washington. There is no work more arduous or requiring so much skill and care as the laying of a submarine cable. A huge factory is required for its manufacture and a great ocean steamer, carrying a corps of able and experienced engineers must be added to the requirements. Possibly what may be considered a most difficult undertaking has been successfully completed by The Okonite Company, Limited, 253 Broadway, New York City. The work was done by them for the Postal-Telegraph Cable Company on January 25, and concerned the laying of a submarine cable in Great South Bay, between Fire Island and Conklin's Point. The character of the sea bed of the Great South Bay is well appreciated by fishermen and yachtsmen. It is full of shoals and sandbars and the constant variations occurring beneath and changes in the character of the bottom necessitate on any occasion the services of an experienced and iron-nerved pilot.

The Okonite Company, Limited, manufactured and laid the cable for the Postal-Telegraph Cable Company so successfully that no cause for complaint has arisen or is expected to arise in connection with this work. The cable is six miles long and completes a line already made

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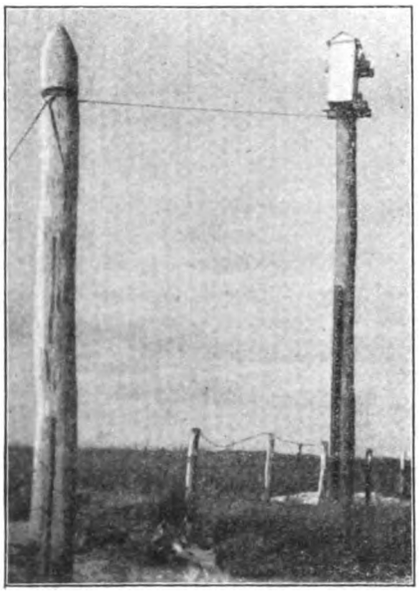
and in use at present for marine service. The entrance of ocean greyhounds is instantly telegraphed from an observation tower to the steamship companies in New York. A line runs from this observatory to the coast line of the island, washed by the bay and there connects with the cable proper.

The bay is crossed by the cable and the other extremity of it connects at Conklin's Point with a well erected overhead line. The overhead line is in itself worthy of note on account of the strength, efficiency and general excellence of it as an installation. It consists of two copper wires, averaging two hundred and ten pounds per mile. This line stretches northward to the tracks of the Long Island Railroad, then continues along an old line, following the main roads until the Borough of Brooklyn is approached. An underground cable then completes the circuit to No. 4 Court street, Brooklyn. Greater New York is thus reached, but not its pulsating centre, Manhattan Borough. In order to reach this, the line is continued along the elevated railway over the great Brooklyn Bridge and underground to the Postal-Telegraph Cable Company's offices, in the building bearing their name.



Cable Terminal Pole at Conklin's Point.

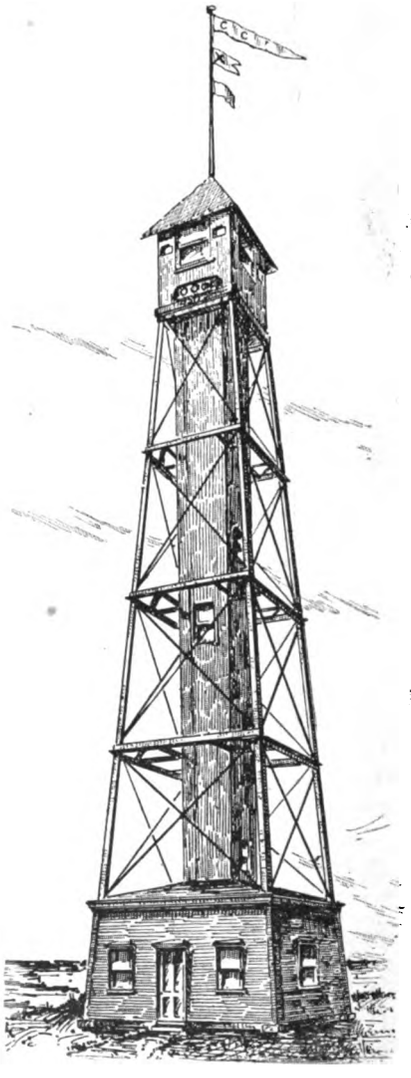
The cable in its completed condition weighs sixty-five tons, is six miles long, one inch and three-quarters in diameter and is built up of six Okonite wires in pairs. The exterior of the cable is protected from injury by galvanized iron wire of unusual strength and thickness. An ordinary ocean cable is not as strongly made as this particular length, the one being described weighing four pounds to the foot; an ocean cable weighing less than twenty per cent. of this.

The testing of a cable of this size was successfully performed at the Okonite factory, at which may be found a huge testing tank, one of the most capacious in the country. It was carefully tested for insulation resistance and put through a "break down" test of thousands of volts. The care with which these tests were made add to the confidence already felt by those concerned with its installation and future operation.

The test being completed, the cable was wound upon giant reels, the reels being turned by a belt reaching out beyond the walls of the factory. After filling each of the three great reels before the end of the cable was reached, each was respectively mounted upon a railroad car, used to carry this great strand from Passaic to New London, Conn. Here they were coiled upon the deck of a large scow, the cable being run out in a flat, oval-shaped spiral.

The difficulty of handling the cable thus far was somewhat increased on account of the long and circuitous path it had to travel, reaching New London. It was necessary to go that distance, however, in order to employ a large enough scow of the draft required. The one employed was of very light draft, and thereby lessened the risk to which all crafts are exposed when traversing the waters of the Great South Bay. Although the scow was eighty-five feet long and thirty-five feet broad it only drew three feet of water when loaded with the sixty-five tons of cable.

The well-known wrecker of New London, Captain T. A. Scott, managed the shipping of the cable, which, to say the least, was a rather difficult job. When coiled on the deck of the scow, the cable rested in six layers, occupying comparatively little space.



Postal Telegraph-Cable Company's Marine Observatory at Fire Island.

Its transportation, when in this condition, was exceedingly easy and represented a departure from the regular routine followed, of a highly interesting nature, nothing having been heretofore attempted in relation to the shipping of the cable of a similar description. A large tug, built for rough weather, took the scow down the Sound to within a short distance of Staten Island and there they anchored on account of stormy weather. The next day the scow was brought from Rockaway Inlet to Fire Island and anchored off Fire Island shore. The end of the cable was then tied to a rope and the rope wound up

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by a steam winch on the Fire Island Shore and there made fast. Another tug was then employed drawing but little water, which towed the scow across the bosom of Great South Bay and the cable began to unwind. It was at this point that considerable skill was exercised for the purpose of preventing accidents, not only to the cable, but to the scow and tug, the shoals and sand bars causing those in charge constant uneasiness. Another fact to be noted was the freezing of the waters, which added to the risk undertaken by the Okonite Company, Limited.

Method of Guiding Cable while Paying Out from the Scow.

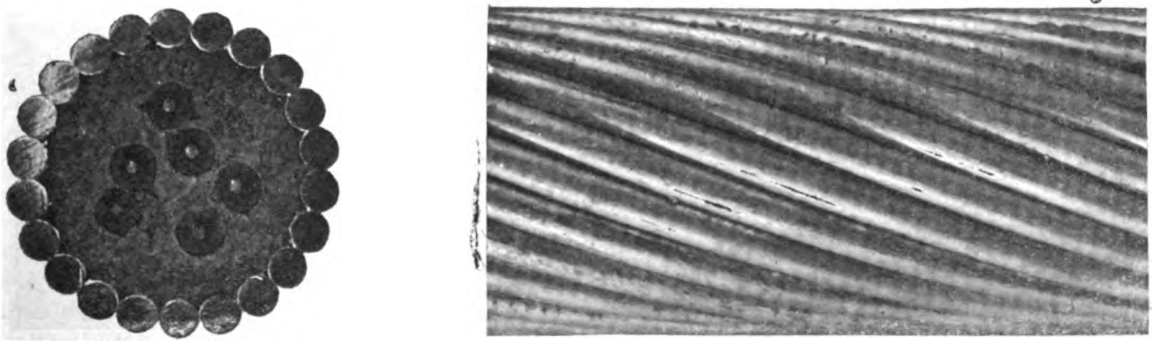
Had the scow grounded or even run foul of a shoal for but a short while, the chances are that the fast congealing waters of the bay would have prevented headway from being made for hours or possibly days to come. Capt. George Saxton guided the tug through hidden but tortuous channels and thereby greatly ensured the success of the expedition. It took but four hours to lay the cable, which was gradually moved over the stern end of the scow as required. The rate at which the cable was paid out was controlled by a rough brake, and a guiding block prevented it from getting into kinks and snarls.

This difficult, though highly interesting achievement was perfectly successful through the additional efforts of another gentlemen, Mr. R. D. Blish, cable expert of the Southern New England Telephone Company, who helped in the shipping and laying of the cable; Mr. E. B. Baker, general superintendent of the Southern New England Telephone Company; Mr. E. G. Cochrane, general superintendent of construction for the Eastern division of the Postal-Telegraph Cable Company, Capt. Willard L. Candee, and Geo. T. Manson, of the Okonite Company, Limited, were also present at the laying of the cable.

The illustrations provided with this article will give the reader an idea of how this work is conducted and lead him to a further appreciation of the care and skill exercised by those intrusted with so important a mission.

Winding the Cable on One of the Reels for Shipment from the Okonite Factory.

The Okonite Company, Limited, have shown great enterprise in all their undertakings, and have, by their careful attention to lesser details frequently achieved success where others have failed. They are one of the oldest and best known of wire companies, and have completed some of the most important contracts ever given to manufacturers of wires and cables.



Full Size End and Side Views of the Okonite Submarine Cable Laid in Great South Bay for the Postal Company.

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BROOKLYN FOOD SHOW, Armory Building, Flatbush avenue and Hanson Place, contains some brilliant electrical effects in connection with the large array of beautiful booths. The exhibitors seem to have vied with each other in designing their booths. Eskays Food Co. exhibited a very handsome sign over their booth. It was made in white ground and studded with small incandescent lamps in pearl, purple and variegated red colors, richly blended together. Fleischman, the great yeast cake firm, have a very ornamanted booth of arches studded with lamps.

We could go on and enumerate the beauties of all the booths with their tasteful electric effects. We advise our readers who desire to secure ideas for the coming Electric Show and Health Exhibition to pay the Food Show a visit. It was very noticeable how the people flocked around the brilliantly lighted booths.

Wm. Boies & Co., electrical contractors, had charge of the electrical work.

Great credit is due to Mr. J. H. Meyers, general agent of the United Retail Grocers' Association, of Brooklyn, for the success of the Food Show.

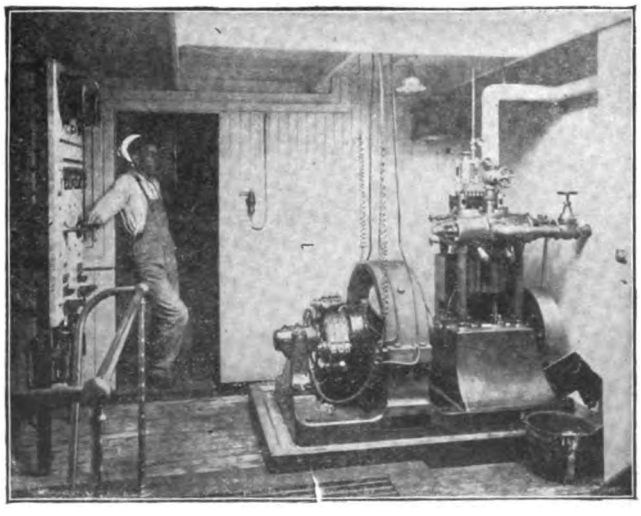
J. H. Wildey attracted unusual attention with his Electrical Engraving Machine. The Food Show closes March 5; our readers have only a few days to get ideas for the coming electrical show.

DIAMOND SHOAL LIGHT SHIP.

Lightship No. 69 has now been anchored on the dangerous Diamond Shoal off Cape Hatteras in 30 fathoms for three months; and having ridden through the gales that prevail off that perilous spot in the Atlantic in entire safety during the roughest weather, has proved to the satisfaction of the Lighthouse Board that a light vessel can be safely maintained there. The captains have now become familiar with the light and until the ship is replaced by a lighthouse, as originally intended, she will be a beacon to be carefully watched for and avoided.

Diamond Shoal Light Ship.

Nos. 68 and 69 are sister steamships built at the yards of the Bath Iron Works, at Bath, Me. No. 68 is the lightship off Fire Island. Both 68 and 69 are unusually powerful composite vessels, 122 ft. 10 in. long over all, 29 ft. ft. 6 in. extreme beam and 22 ft. moulded depth. They are provided with propelling machinery to enable them to steam to their stations, and, also, in case of necessity, to steam away from their dangerous positions. The engines are simple condensing vertical, with a cylinder 20 in. in diameter and 22 in. stroke, developing 350 H. P. at 150 revolutions. Steam is furnished at 100 lbs. pressure by a steel Scotch boiler 12 ft. 2 in. in diameter and 11 ft. long. Two vertical donkey boilers furnish steam for the electric lighting plant, windlass, pumps, fog signals and for heat-



Diamond Shoal Light Ship Plant.

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ing. The vessels are also fitted with steam steering gear, bells, a steam winch and full equipment of anchors and chain cables.

The two masts are of steel; each, exclusive of the flag pole, 64½ feet high. The electric lights are suspended at the mast heads, and are surrounded by a gallery for day signals.

To avoid chance of breakdown the electric plant on each vessel is in duplicate. Each plant consists of two marine generating sets with dynamo and engine both built by the General Electric Company, of Schenectady, N. Y. The four-pole dynamos are 8-kilowatt, 350 revolution machines, directly connected to 4½x4 in. double cylinder engines. The switchboards are of Vermont marble and the wiring appliances used throughout are of the type approved by the United States Naval Board of Inspection. The dynamos furnish 100-volt current to eight 100-candle power lamps, four at each mast head, and forty 16-candle power lamps throughout the vessel. The mast head lights are each enclosed in a lens lantern, three being used and the fourth held in reserve. Connected in circuit to the mast head lights is a device making and breaking the circuit and lighting and extinguishing the lamps at regular intervals. A fixed white light shows for twelve seconds and is followed by an eclipse of three seconds. The focal plane of the lights is 57 feet above the sea, and they will be visible 13 nautical miles away in clear weather. Great reliance is placed on the electric plants, and in their construction more than ordinary care has been taken on account of possible consequences of a breakdown through accident.

(We are indebted to the courtesy of the New York Tribune for the photographs from which the illustrations were made.

FALLS WILL LIGHT BUFFALO.

Niagara power will, it is now expected, be used to light the city of Buffalo by August 1st. The Buffalo General Electric Company, which at present has a contract of 3,000 horse-power from the Falls, and which will contract for more as it is needed, has decided to build a new power-house at once, and as soon as this is completed and the new machinery installed, the present plant of the company, on Court street, will be given up, and steam power, so far as the Buffalo General Electric Company is concerned, will be a thing of the past.

The new power-house will probably be located on Wilkeson street, where the company now owns a very valuable site. Three sites were seriously considered at the recent meeting of the directors the latter part of last month. These were the one on which the present plant is located, a site not owned by the company and the Wilkeson street property. The sentiment of the directors was in favor of the latter, and there is little doubt that it will be selected by the committee in whose hands the matter was left for final decision.

Ground for the structure will be broken at once. The new plant will be one of the most modern in every way in the country. The machinery alone will cost $160,000, exclusive of the eleven step-down transformers, which are being built by the General Electric Company of Schenectady, and which will be furnished by the Cataract Power and Conduit Company.

The power will be received in the eleven transformers, and will be transmitted through two rotary converters to four frequency-changers, which will change the frequency of the current from 25 cycles, in which it is sent from the falls, to 60 cycles. From the frequency-changers the current will be distributed among fifteen motors. Each motor will drive two arc machines, one on either side, making thirty arc machines in all.

There will be a total horse-power of 5,900. The 30 arc machines will have 3,000 horse-power, the incandescent machines 2,400 horse-power and the power-circuit motors 500 horse-power for distribution to small motors such as house-fans or shop-motors. There will be a 50 per cent. reserve of the incandescent lighting and power circuit and 25 per cent. reserve of the arc lighting.

With the apparatus already ordered, the new plant will light 3,000 arc lights and 24,000 incandescent lights and will be able to run about 600 horse-power of motors. When the demand exceeds this, the apparatus will be increased, as there will be room for three times the apparatus ordered. The company now lights 2,862 arc lights, 2,000 on the east and the rest on the west side.

The Buffalo General Electric Company expects to complete the new plant and light the city from end to end inside of six months' time.—Greater Buffalo.

LEGAL NOTE.

Cement-Lined Pipe Patents Sustained.—In the Circuit Court of the United States for the District of Connecticut, Judge William K. Townsend has just handed down an interlocutory decree in the case of the suit brought by the National Conduit Manufacturing Company against the Connecticut Pipe Manufacturing Company. This case was brought by the National Conduit Manufacturing Company against the defendant company for infringements of patents on the well-known cement-lined iron pipes for electrical subways, all of the patents on which are owned by the plaintiff company.

The patents in question cover broadly the use of cement-lined iron pipes for electrical subways. The decision in favor of the National Conduit Manufacturing Company enjoins the defendant company perpetually from the manufacture, sale or use of such cement-lined pipe, and the construction of such subways. The decree further orders that the defendant must compensate the plaintiff for all profits, gains or advantages which it has obtained by reason of all infringements heretofore, and appoints a referee, with full power, to examine into the business of the defendant to ascertain and assess the amount of damages. The National Conduit Manufacturing Company is now proceeding against the receiver of the defendant company, in order to get damages for the infringements in question, in accordance with the decree of court above mentioned, and prevent him from disposing of the pipe, etc., which came into his possession under the receivership.

MUNICIPAL ELECTRIC LIGHT AND POWER IN GERMANY.

In the following cities in the German Empire the municipal authorities own and manage the electric works that supply light and power: Bremen, Barmen, Cassel, Darmstadt, Düsseldorf, Elberfeld, Hanover, Cologne, Königsburg, Lübeck. and Pforzheim. All of these cities, with the exception of Hanover, also own the gas works. The following cities have constructed the electric works for the purposes of light and power, but have leased the management of the same to private operators: Aix la Chapelle, Chemnitz, Frankfort, Strasburg, and Stuttgart, all of which, with the exception of Chemnitz, are cities where the gas works are under the management of private corporations. In the following cities, private companies have established electric works with the agreement that, under certain conditions, the municipal authorities shall have the privilege of securing absolute control and ownership by purchase: Altoona, Dessau, Gera, Hagen, Heilbronn, Leipsic, Mülhausen, Stettin, and Zwickau. Of these cities, the gas works are under private control in Dessau, Hagen, Mülhausen and Zwickau.

James T. DuBois,
Consul-General.

St. Gall, Jan. 28, 1898.

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ERECTION OF TELEGRAPH AND TELEPHONE LINES.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

The Line.—The consideration of a line from certain standpoints makes the subject one of deep interest and importance to the earnest reader. A line is merely a conductor supported at frequent intervals by insulators. Its utility and efficiency depends entirely upon the excellence of these supports and its own conductivity. The material of the line merits the closest attention, and its resistance as compared with that of its supports provides a means of estimating the loss or gain by any specific change in either. Usually conductors are of either iron or copper for line work.

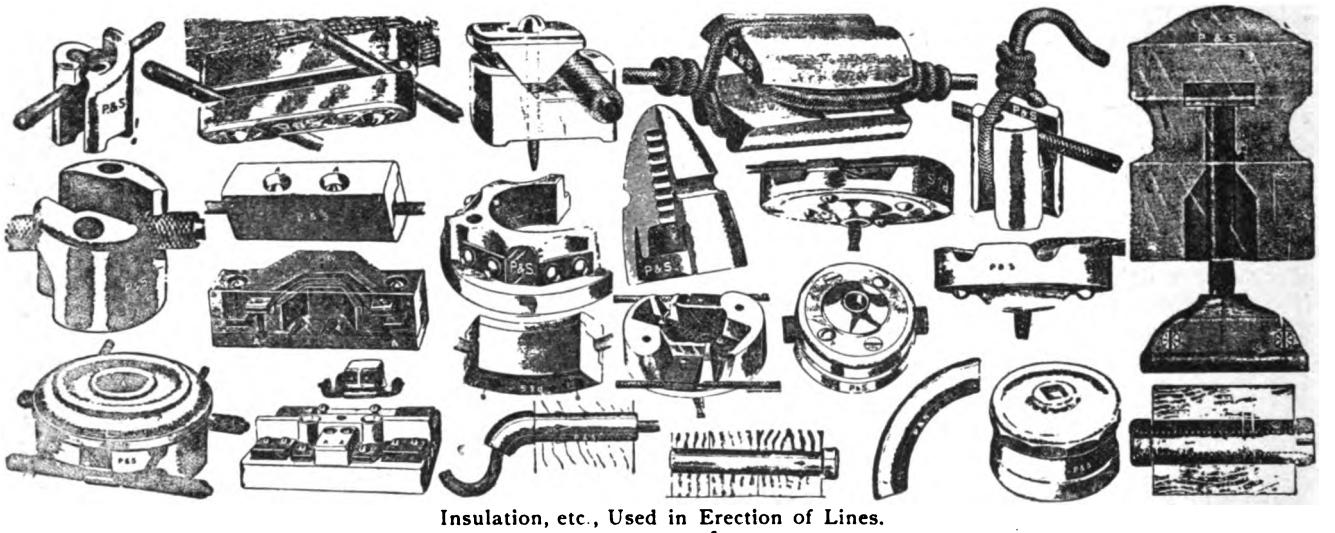
wires of the same length and diameter are compared, and equally so should their diameters vary, because two wires of the same material and same length have a resistance inversely proportional to the square of their diameters. For such purposes a mil foot of each would show the desired relationship in an easy manner. A mil foot is one foot of the metal .001 of an inch in diameter.

The line in telegraphic practice is gradually being changed from galvanized iron wire to copper. This is an advantage in every respect, but means a heavy expense to the company. The leaks that occur from the line to the earth, due to the following—

Grounds,
Crosses,
Poor insulation,

are at times very bad, draining the system of its current and thereby destroying its effectiveness to a great extent.

The insulators may be covered with a film of rain



Insulation, etc., Used in Erection of Lines.

The insulators are usually of glass, although those used indoors are made of hard rubber. To give an idea of the extraordinary difference between a good conductor and an insulator a comparison made by Fleeming Jenkin might be recalled.

"The difference between a copper conductor and a gutta-percha insulator is about as great as the difference between the velocity of light and that of a body moving through one foot in 6,700 years." The following table gives a list of conductors in the order of their conducting power, also showing the decreasing insulating property of various materials:

Conductors.	Insulators.
Silver	Air
Copper	Glass
Zinc	Hard Rubber
Platinum	Shellac
Iron	Gutta-percha
Carbon	India Rubber
Acids	Porcelain
Salt Solution	Earth
Water	Ice
Wood (damp)	Oxides

A copper conductor is used as a basis for estimating the resistance of wires of other metals. In a table given by Franklin Leonard Pope a means of arriving at this fact by a simple calculation is shown:

For brass,	multiply	copper	resistance	by	4.5
" German silver,	"	"	"	"	12.9
" iron,	"	"	"	"	5.9
" platinoid,	"	"	"	"	19.5
" platinum,	"	"	"	"	14.8

This valuable little table will prove very useful when water, the poles may decay and get soaked, and floating dust settling upon both insulator and line may provide a path to earth. In comparison with pure copper, clean rain water has 40,653,723 times the resistance. When mixed with foreign matter its conductivity greatly increases.

The earth in telegraphy acts as a return circuit; the extremities of the line being grounded by means of a large plate, either of copper or iron. This is set into the earth and from it the signals either extend forward or return through the instruments at each end. The earth, if very dry or sandy, will be a poor return circuit and the line suffer in consequence; therefore moist earth is the best material in which to ground the line. In a city the gas or water-pipe system is sufficient.

The resistance of an earth return is practically negligible, and is therefore lightly considered when tests are made.

Its specific resistance is very high, but the enormous cross section is ample enough to secure an almost complete reduction in resistance.

The ground plates, if made of copper, are about $\frac{1}{16}$-inch thick and about 4x4-feet in area. A galvanized iron plate is very much cheaper and just as serviceable. Contact is made with the connecting wire by soldering it, and the joint is protected by a non-corrosive substance from electrolysis and chemical action. If the soil is very dry a pit should be dug and the plate laid in it, surrounded by coke or charcoal, or other refuse equally applicable. A granitic district would probably develop some such a peculiarity.

Posts—The poles will last long if their ends are creosoted or soaked in some silicic or protecting compound. In moist soil the decay quickly commences, and when

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LIGHTNING AND TALL BUILDINGS.

During the period of thunder-storms the people living in large cities are oppressed with a sense of dread at the brilliant flashes of lightning and deep reverberations that follow. Many that work in tall office buildings are frequently affected with a feeling of awe and occasionally with despair when the storm approaches a climax. Investigations will probably show that the majority of tall buildings built with steel frame-works are particularly exempt from the danger and destruction that are apt to follow upon the heels of a high potential discharge. There are reasons for this immunity from danger that are particularly interesting in the case of steel structures.

To begin with, a flash of lightning is a static discharge which may occur between two clouds, or a tall building and a cloud overhead. The presence of a charged body of vapor above inductively affects all bodies in its vicinity, the taller office buildings more than any other. It is just as probable, and in fact almost a certainty, that the discharge leaps from the tall office building into the cloud as much as the supposed downward thrust from the cloud above. A positively charged cloud will develop a strong negative charge in the building or buildings below; but however great the potential of this discharge may be, even if it be measured in millions of volts, those within enjoy the most perfect freedom from danger and are better protected as they are than in the fancied security of the ground floor of the ordinary old-fashioned structure.

Those who remember the experiments of Faraday as described by him will realize that a metal cylinder or cage will not, when charged even to a very high potential, show the least sign of electrical influence within. A tall building is no more and no less than a great steel cage, and a stroke of lightning would not, unless under the most extraordinary circumstances, possibly affect the interior, and cause within it the destruction so popularly feared. In fact, it is very likely, on account of the increasing number of steel structures in large cities, that storms of an electrical character do not assume the same rage and fury that they might if the buildings were not present.

A great deal of the impendiug charge is dissipated, that is, neutralized, by the leakage from tall buildings into the moist atmosphere. It would probably take a very severe storm and an unusual electric pressure to cause any evil effects; but if the severity of the storm is such as to cause actual damage, it would probably be found that the damage had been done by the discharge leaping from the framework of metal to some other point on the exterior of the building.

Protection in a steel structure is very great, possibly the best that could be practically imagined, but it is not an absolute safeguard in a scientific sense because a highly oscillatory discharge, occurring between the building and the cloud might, in the light of our present knowledge, leap from point t o point through several air-gaps, choosing what is technically described as an "alternative path."

Yet, in general, a tall office building is like a huge lightning-rod of colossal proportion which will, in the majority of cases, form an efficient protecting shield to those working within its confines and trusting to its wholesome security. The fact must not be forgotten, however, that the discharge bursts from the building at as high a pressure as it is received from the aqueous mass above.

FOUR THOUSAND HORSE-POWER AT ELEVEN THOUSAND VOLTS.

The illumination of Buffalo by electricity genérated at Niagara Falls marks an important epoch in the history of power transmission and electric lighting. The Buffalo General Electric Company have decided to equip a new station at Niagara, and with the power developed there oparate their lines in the city of Buffalo. It would be more exact to say that the Cataract Power and Conduit Company will supply current to the station, which will, with the aid of eleven static transformers raise the pressure to the desired point and send it over the line. Each transformer is of three hundred horse-power size or four thousand horse-power in total.

Eleven thousand volts will be received by them to be transformed down to three hundred and sixty-two volts. Two special cables will feed current to the transformers, each cable heavy enough to carry full load. When the three hundred and fifty-volt current is received, it will be spread among various machines to be supplied for either of the three purposes: high tension, direct currents for street lighting; low tension, direct current for small power motors, and high tension, alternating for inside arc lighting, etc.

The new plant will therefore be made large enough to contain twelve two hundred and fifty-light units, in addition to some frequency changers. The functions of these large machines will be that of changing the current received from twenty-five cycles a minute to sixty-two and a half cycles a second. The frequency changer may be understood as being merely a motor generator, which, receiving power, operates a motor and thereby rotates the armature of an alternator to which it is directly connected. The various features of this highly interesting lighting, power and transmission plant represent the direct application of the most modern engineering appliances, as well as a degree of enterprise that speaks well for the directors of the Buffalo General Electric Company.

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aided by the burrowing of insects rapidly weakens the structure. A pole when wet falls quite considerably in resistance. As a rule the comparison is made between the resistance of the pole and that of the insulator and arm.

$$\frac{\text{resistance of pole}}{\text{resistance of arm} + \text{resistance of insulator.}}$$

This expresses the ratio between the two in a simple manner.

Cross-arms.—When the cross-arms of a pole are dry the resistance is about 100,000 ohms, but when wet this may fall as low as 4,000 ohms.

If left exposed to the air without even a coat of paint, the fall in resistance is very noticeable. The least resistance a cross-arm will have is about 1,000 ohms, that has not been absolutely soaked in water.

Treating the poles and arms to a preparation that does not absorb moisture would enhance the excellence of them as insulators quite considerably. The supporting power of a pole and its resistance in ohms are two entirely different and unproportionate qualifications, though they may bear a slight relation to each other.

Insulators.—The common form of insulator for line use is the single petticoat glass insulator so familiar to all. This is not a very excellent device for the purpose, as it is hygroscopic and brittle; but its cheapness and convenience make it a most popular article of use. The floating dust and begriming smoke soon impair their insulating property in the city or its suburbs. The maximum resistance per mile is about 60,000 to 100,000 ohms, depending upon the humidity of the air and their cleanliness. This may fall as low as 25,000 ohms per mile, if damp and dirty.

Varley, in his report to the Western Union Telegraph Company, states that the cleansing of insulators almost triples their resistance.

The improvement of a line depends greatly upon the insulators used, German porcelain are about the best. The glass insulator is about 5 megohms in resistance, while German porcelain insulators are over 15 and sometimes 20 megohms in resistance (1 megohm = 1,000,000 ohms). It is generally cheaper to improve the insulation of the line than to use a copper line. It costs about four times as much to increase the conductivity by the use of copper as to use new insulators of high resistance.

The ratio between the conductivity of the line and that of the insulators is 1 : 10,000 with a No. 9 iron wire (Pope) of 15 ohms per mile, mounted on glass insulators of 4.5 megohms a piece, and 30 poles to the mile. This is generally about the average condition of a line, and any increase in this ratio means a gain in current.

QUESTIONS FOR REVIEW.

(1) What is a line?
(2) What difference exists between an insulator and conductor?
(3) State the causes of leaks.
(4) Why do insulators cause leakage?
(5) How is a ground return made?
(6) What preparation is used to protect posts?
(7) By what means is the resistance of insulators increased?
(8) What causes a depreciation in the resistance of insulators?

THE REVOLUTION IN POWER ENGINES.

It is well known that the steam-engine after its inestimable work during the past century and with the improvements it has undergone during recent years, is still an incorrigibly wasteful and imperfect motor. Not only does it utilize but a very small percentage of the energy stored in the fuel which it consumes, but it also becomes burdensome through its inseparable companions, smoke and soot.

With the discovery of any new motor it was expected that the smoke-stacks would be doomed; many expected this when the first electrical motor was introduced, but alas, the steam engines and smoke-stacks became still more evident instead, as the generation of electricity depends yet to a great extent on steam power.

A recent invention by R. Diesel, Munich, who has been working on the problem for the last fifteen years, claims to create a complete revolution in the production of power—a revolution such as has probably not been experienced before in human history. Diesel's caloric motor, which is no longer an experimeut but an established commercial factor, pretends to nothing less than to finally supersede the steam-engine.

As aforesaid, the steam-engine, to say the least, is not an ideal machine, and there is no prospect that it can be much more improved in the future, since from a scientific standpoint, the method on which it acts has inherent faults beyond the control of the mechanic.

To erect and equip one of our modern marine engines for a large steamer or man-of-war requires an iron mine; to operate it, a coal mine.

It will astonish a great many people to learn that one of our ordinary high-pressure steam engines utilizes only four per cent. of the energy stored in the coal consumed, a Corliss engine of the best modern type may reach eight per cent. while a triple expansion engine of 1,000 H. P. or more, with condenser and perfected cut-off, does not surpass 12 to 13 per cent. as the maximum achievement of the best steam-engine at its present state of development. The question naturally arises, what becomes of the remaining 87 per cent. to 96 per cent. of the coal consumed? In the first instance, 20 to 25 per cent. are partly lost in the furnace and partly in creating draft in the smoke-stack, incidentally also causing the smoke nuisance which is becoming more annoying from day to day, especially in large cities, and against which the boards of health are powerless. The remaining 70 per cent. are lost through radiation at every point and by the costly evaporation of water, for, while the heat created under the boiler may reach 2,500 to 3,000 deg. F., the steam created will, at the very highest pressure used, have a temperature of only 390 deg F., which means a dead loss by conversion and recondensation of two-thirds of the heat, leaving available for work only 24 to 26 per cent. To improve upon this the inventor of the Diesel motor conceived the following plan: Pure air is compressed in the cylinder of this motor, thus generating a temperature of about 600 deg. C. The fuel to be used, such as gas, petroleum or powdered coal is thereafter injected into the compressed air where it is gradually and completely burned up at a much lower temperature than ever before accomplished. During combustion and during the sncceeding expansion, it is entirely turned into work. The injection and combustion of the fuel takes place as the piston in the cylinder begins its return stroke. It ceases when it has reached about one-eighth or one-sixteenth of its way back, and it is so regulated that the increase in the temperature created by the compression ef the air and subsequent combustion of the fuel, is reduced by the cooling off due to the work done during the succeeding expansion.

Thus, practically, there is no increase in sensible heat since the heat caused by the combustion of the fuel is immediately turned into power and the motive power thus gained is only reduced by the small amount required for the compression of the air.

The practical operation of the Diesel motor during nine months shows that it can turn 26 per cent. of the heat units of the fuel consumed into mechanical power, which means an effect of 200 per cent. compared with the best steam-engine and 150 per cent. compared with the best gas and

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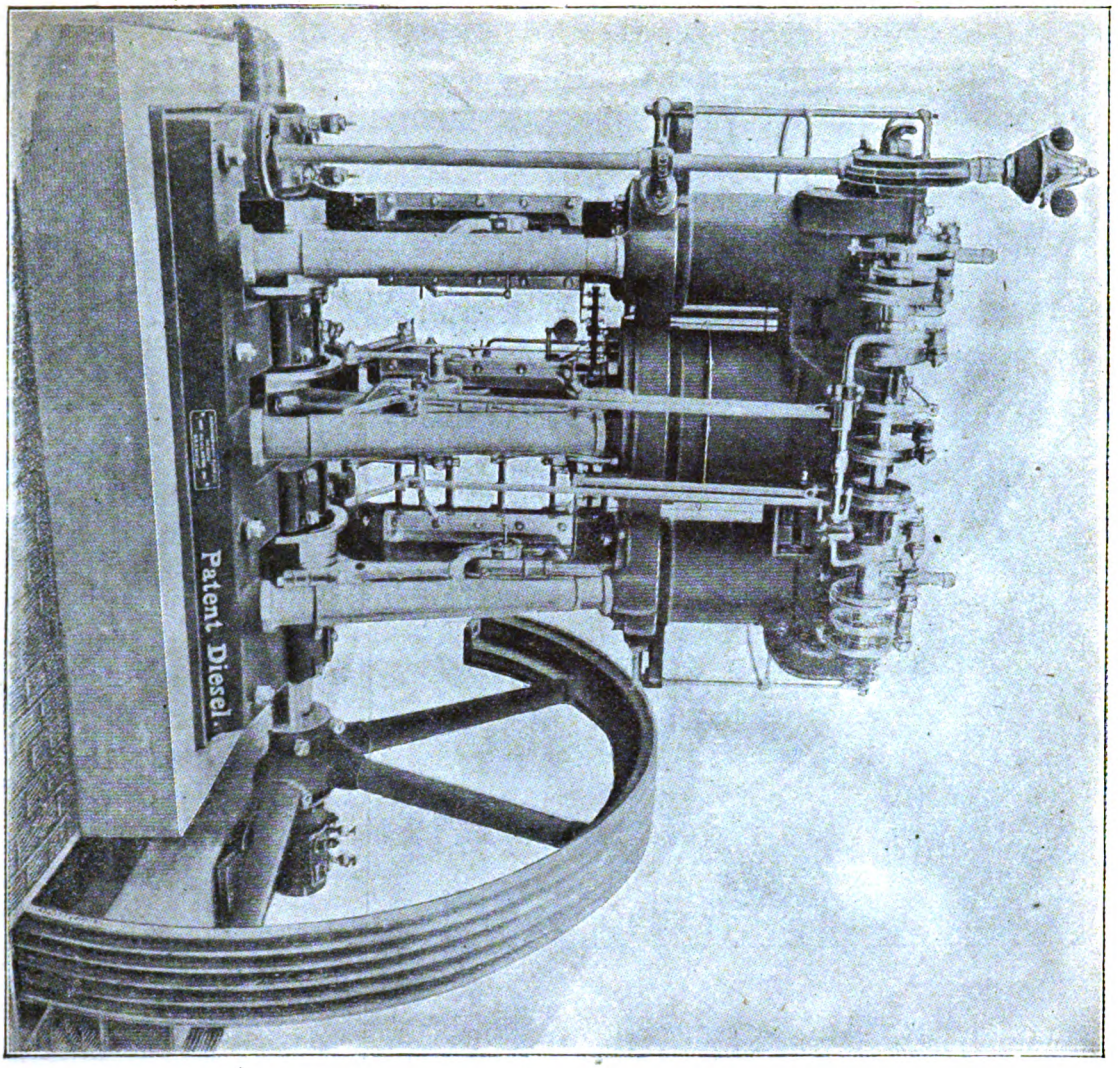
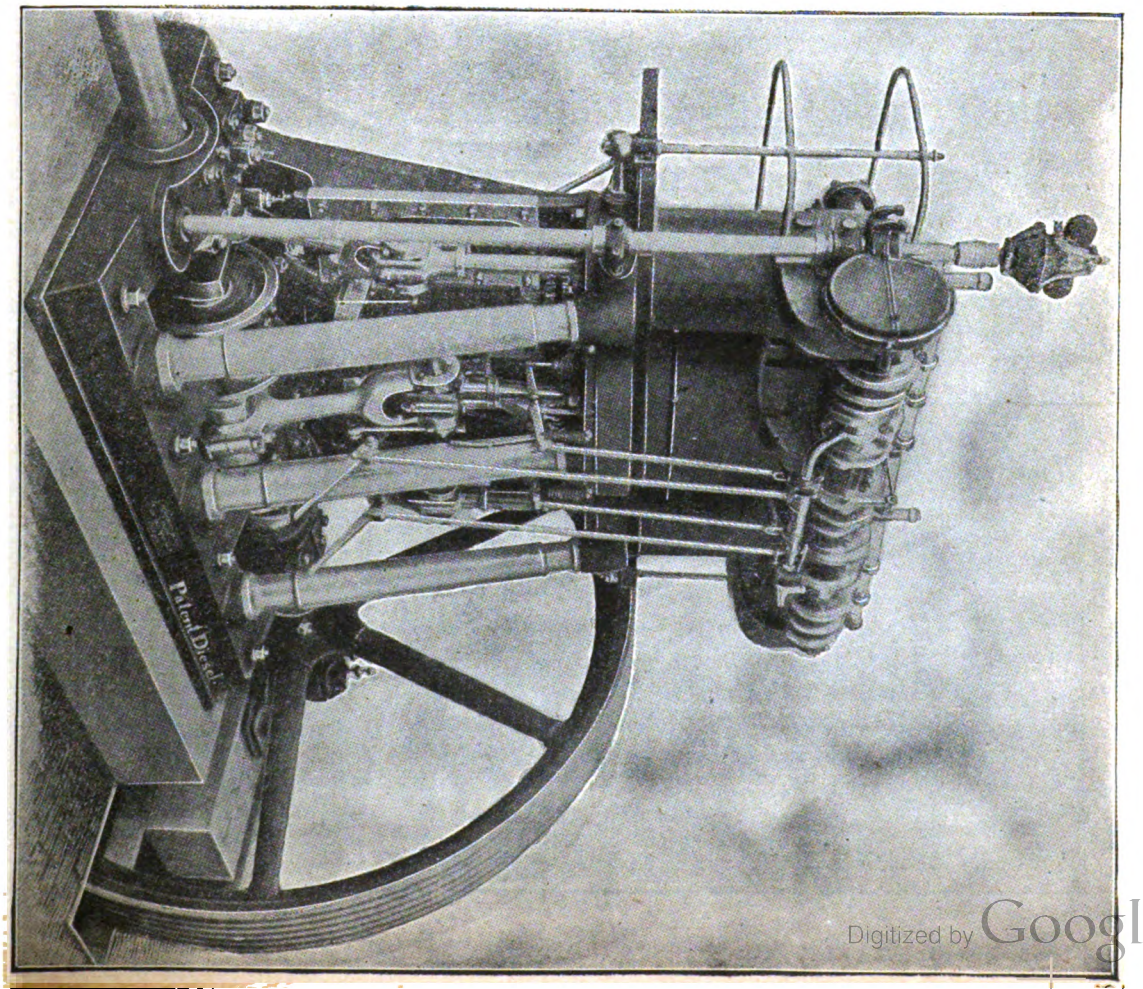


Three-Cylinder 150 Horse-Power Diesel Motor. Front View.



Three Cylinder 150 Horse-Power Diesel Motor in Perspective.

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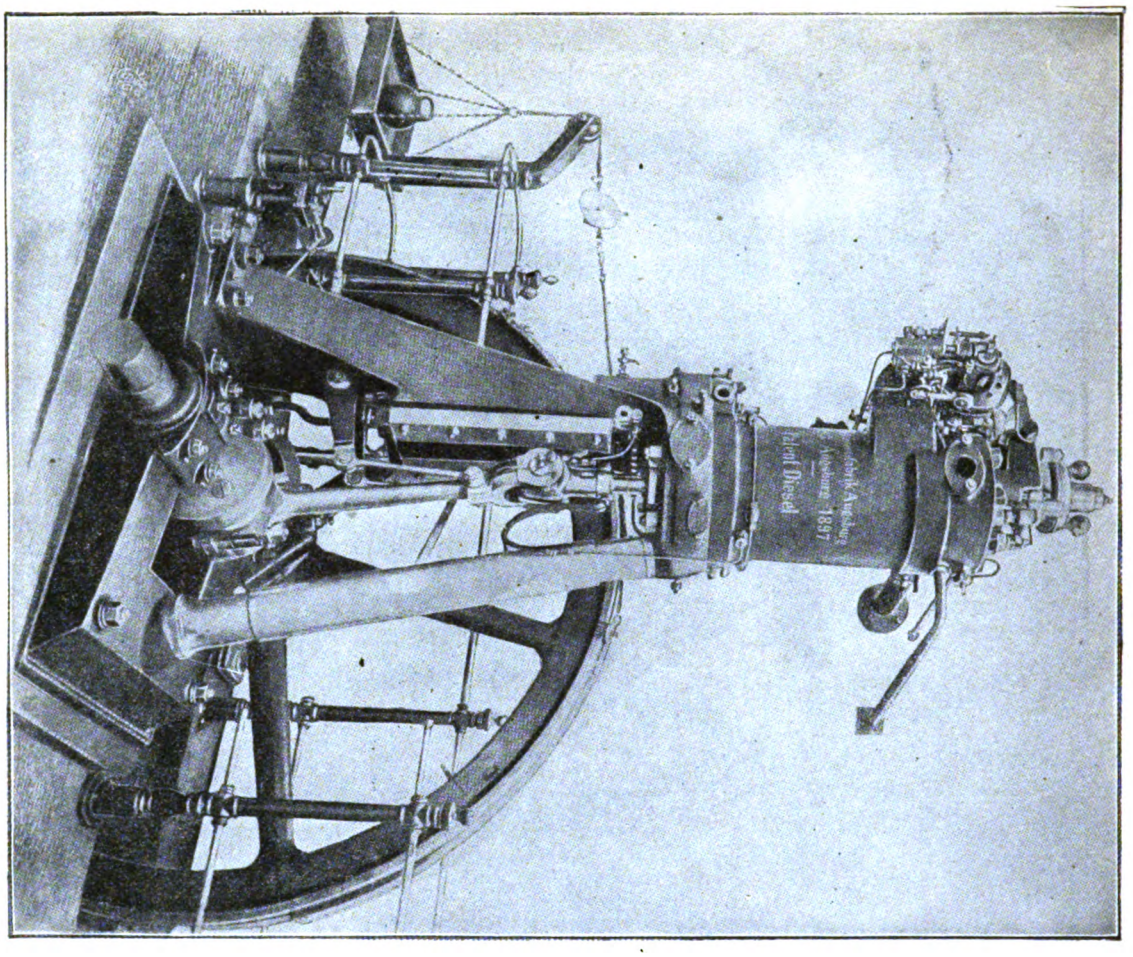
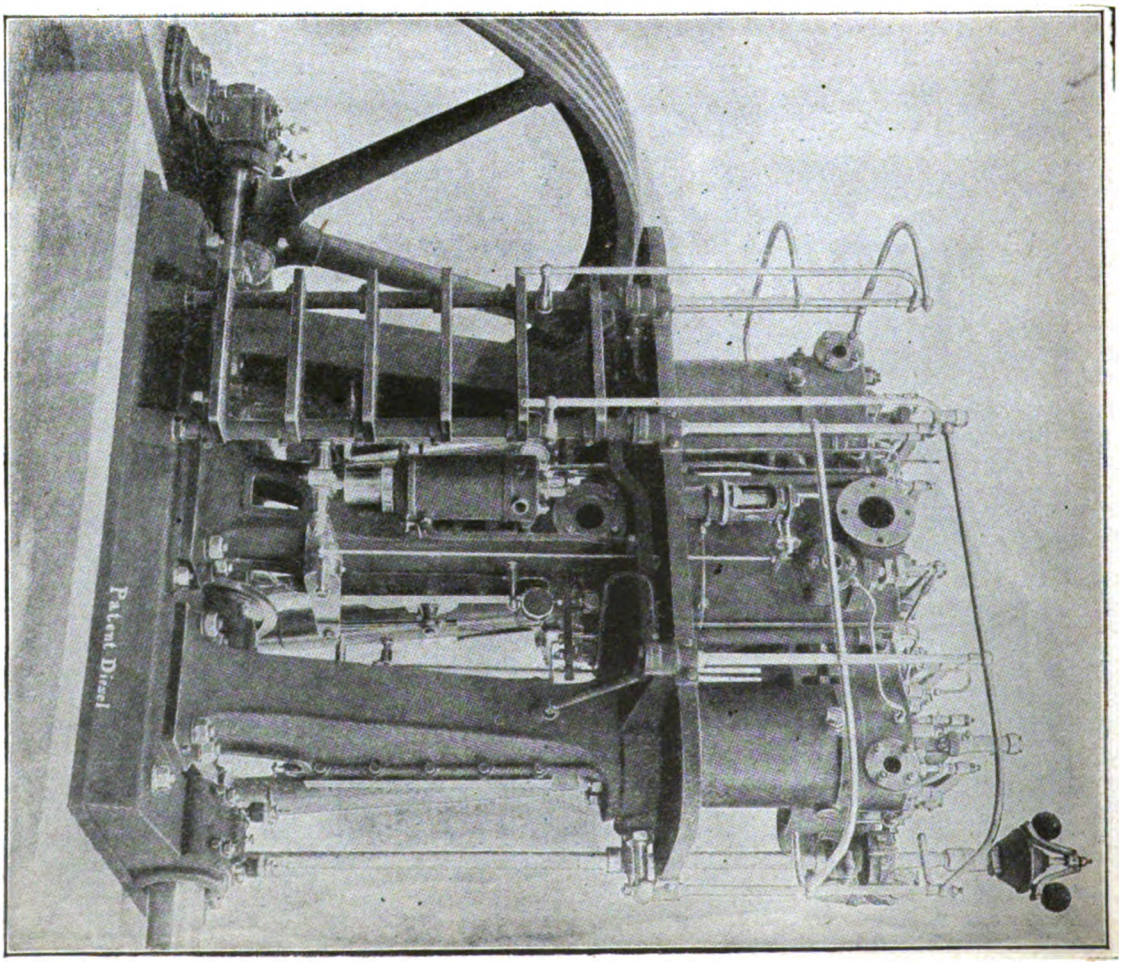


Single Cylinder 20 Horse-Power Diesel Motor.



Three Cylinder 150 Horse-Power Diesel Motor. Rear View.

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oil engines. But other features of this remarkable motor, which has met the fundamental requirements of a perfect heat motor to a degree not hitherto attained by any other device, are not less important.

The Diesel motor will work with nearly equal economy at half as at full load, and in this it therefore excels even the best steam engines.

The construction of the Diesel motor is much simpler and therefore subject to less repairs, as, in comparison with the ordinary gas or oil engines, no igniter, gas atomizer or mixer is necessary, while compared with steam engines, no boiler, condenser or coal bunkers are required, an advantage which can hardly be over-estimated in steamship building.

The injection and combustion of the fuel can be regulated automatically according to the power required, and changes in the load of the motor are governed to a nicety.

The motor can be set to work without loss of time, since once operated it is again started by simply opening a valve admitting the stored compressed air into the cylinder. It runs almost noiselessly and without shock or jar, and in this differs materially from the best existing gas or oil engines.

The interior parts will not soil, as the fuel used is completely consumed, which is shown not only by a chemical analysis of the waste gases, but also by their absolutely odorless escape into the air.

Thus far the fuel used has been mainly petroleum, but it has been demonstrated that common illuminating gas is a perfect material for this purpose, and the use of producer gas at American prices would, it is estimated, furnish power at one-half the cost of the steam generated with coal.

Expert commissions from all civilized countries, including Japan and Australia, have been sent to Augsburg, where the motor has been in actual operation for fully a year, and their unanimous testimony gives the general verdict that its advent must be hailed as the beginning of a new chapter in the application of heat as motive power. The motor has been examined and warmly approved by the great scientists, among them by Lord Kelvin of Great Britain. It is expected that the suppression of boilers, coal bunkers and condensers, will revolutionize the machinery of torpedo boats and sea-going vessels.

At Nuremberg, Diesel's motors are being built at present for street cars and general railroad work.

Mirrlees, Watson & Yaryan, the world-renowned marine engine builders of Glasgow, are building reversible engines on the Diesel system, while European locomotive works are adapting the system for locomotives.

The Diesel motor has been patented in all countries where patents are granted for inventions, and the rights for United States and Canada have been acquired by a company since incorporated under the laws of New York State as the "Diesel Motor Company of America," with offices at No. 11 Broadway, N. Y.

THE GAS ENGINE IN ELECTRIC LIGHTING.

The late Mr. Denny Lane, of Cork, had a great idea o the future of the gas engine in connection with electric light installations, and believed that electricity could be generated in a comparatively small station in the immediate vicinity at a cheaper rate than it could be furnished from a central generating station at a distance. Or, in other words, that a moderately large user could supply himself with electricity at a cheaper rate than he could purchase it from a corporation or company. Mr. Lane went so far as to advise gas companies to take up the question of electricity supply by means of a comparatively large number of generating stations, say one in each street, using gas engines as a source of power. Unfortunately for the success of his plan, at that time gas engines were costly in the first place, and the running was not sufficiently steady.

I know of several small installations, using engines of three horse-power to fourteen horse-power nominal, that have been running for years with satisfactory results to the owners. But it is difficult to get sufficient data, either as to the cost of electricity per unit, or as to the actual lighting value obtained, to admit of a full comparative statement being prepared, so it is not possible to say accurately whether the gas engine, dynamo and electric plant are capable of developing a larger lighting value per cubic foot of gas used than would be obtainable by the direct agency of incandescent burners. Allowing that 20 cubic feet of gas are used per horse-power, and accepting the usual estimate that one horse-power is sufficient to supply 10 nominal 16-candle power lamps we get a duty of about eight candles per cubic foot of gas, or less than half that claimed for the incandescent burner. So that unless there are other special advantages it would appear that the latter system is by far the cheaper. A decided advance has, however, been noticeable in the introduction of gas engines specially suited for the generation of electricity. An installation of this kind at the Leicester railway station, belonging to the Midland Railway Company, includes six gas engines, four of 90 horsepower each and two of 50 horsepower. And the cost of the electricity produced is said to compare favorably with that at other stations belonging to the company where steam engines are used. The great advantages of the gas engine for this purpose is the fact that it can be stopped and started instantaneously without loss of time and expense in getting up steam, there is absolutely no working expense while it is lying idle and the consumption of fuel is proportioned to the actual power used.—English correspondence American Gas Light Journal.

A 108-MILE ELECTRIC TRANSMISSION PLANT is under consideration in Southern California. The undertaking involves the erection of a dam across the Kern river, in Kern county, Cal., and the construction of a line to convey the high-tension current to Los Angeles. The Kern river drains an area of some 2,345 square miles, and a total of about 12,000 horse-power can be obtained. A pressure of 30,000 volts is proposed for transmission. While this is exceptionally high, the dry atmosphere and infrequent rainfalls warrant its adoption. The dam already mentioned will form a storage reservoir, with a volume of about 13,721,400,000 gallons, or the equivalent of 42,000 acre-feet. Should the project be carried out, it would be by far the longest electric-power transmission line in the world.—Mfrs. Gazette.

HOLLOWAY & IRISH, Electrical Engineers and Contractors, complete electric light and power installations, dynamos, motors, fans and exhaust wheels, switchboards; electrical supplies and repairing a specialty, Electrical Exchange Building, 136 Liberty st., N. Y., are installing a hygienic refrigerating plant in a large apartment house uptown. This is the second plant of this kind installed by Holloway & Irish. It consists of an electric motor running a pump and a motor running a brine and ammonia machine for generating cold air. The switchboard will be of marble, 4 x 5 feet, containing Weston voltmeters, thermostat gauges, switches, etc. The first plant was installed in Smith & Sill's big store on Eighth avenue, N. Y. Also preparing to install one of these plants for cold storage for furs, to keep out moths.

NEW ELECTRICAL CORPORATIONS.

Merced, Cal.—Merced Falls Electric Co. has been incorporated by James G. Ruddle, E. D. N. Lehe, James T. Peck, J. D. Bradley and C. E. Green. Capital stock, $100,000.

Streator, Ill.—La Salle County Railway Co. has been

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incorporated by C. E. Rathbunn, W. H. Boys, W. H. Holcomb, to build and operate a street railway in the counties of Cook, La Salle, Grundy, Will, Kendall, Kane and Dupage. Capital stock, $500,000.

Pueblo, Col.—The Colorado Telephone Co. is about to erect a $10,000 building at Pueblo, and will complete its line from Pueblo to La Junta this year.

Belmont, Ill.—Belmont Gas and Electric Fixture Manufacturing Co. has been incorporated by S. H. Ales and Richard E. Burke, for manufacturing purposes. Capital stock, $2,500.

New York, N. Y. — The Knickerbocker Telephone and Telegraph Co. has been incorporated to operate a telephone and telegraph system. Capital stock, $7,500,000.

Bronxville, N. Y. — Ward Leonard Electric Co. has been incorporated by H. Ward Leonard, Charles E. Carpenter, Richard H. Mansfield, Jr., and Henry P. Bull, to manufacture electrical appliances. Capital stock, $100,000.

West Superior, Wis.—City Clerk may give information about new lighting plant.

Seguin, Tex. — The electric-light plant will probably be owned by the city.

Buffalo, N. Y.—The Buffalo Telephone Co. has been incorporated by G. K. Birge, D. N. Lockwood, L. B. Crocker, W. H. Kinch, James Kennedy, William B. Hoyt and R. J. Getz, to operate a telephone system in Western New York, Pennsylvania and Ohio. Capital stock, $500,000.

Thomasville, Ala.—The Noble gin plant has been purchased by W. I. Waller, of Nicholas, Ala., who will install an electric light plant.

Cumberland, Md. — The Maryland, Pennsylvania & West Virginia Telephone Co. has obtained franchise for telephone system, etc.

Cumberland, Md.—The Ambos Construction & Electric Co., of Cleveland, has been awarded contract for the erection of the $34,000 electric light plant at Cumberland, Md.

Ludington, Mich.—The Mason Telephone Pay Station Co. has been incorporated with a capital stock of $10,000.

Hagerstown, Md.—Powell Evans will construct a dam across the Potomac river near Hagerstown, for the development of water-power, and to erect an electric plant for transmission of power to factories, etc.

St. Louis, Mo.—The Mississipi Valley Electrical & Manufacturing Co. has been incorporated by D. H. Lohse, Edward Buder, A. F. Ittner, and Eugene Buder. Capital stock, $100,000.

Cape Girardeau, Mo.—The Jackson Telephone Co. has been incorporated by Samuel Hitt and others. Capital stock, $2,500.

Trenton, Mo.—The Trenton Light & Power Co. has been incorporated by C. O. Hoffman, E. M. Harber, W. O. Garvin and others. Capital stock, $30,000.

St. Louis, Mo.—The Moe & De Voll Incandescent Gas Co. has been incorporated by T. M. Moe, C. H. De Voll and H. E. Green. Capital stock, $250,000.

Bamberg, S. C.—The Mayor may be addressed concerning electric-light plant.

Dayton, Tenn.—Town Clerk may give information concerning establishment of plant for electric lighting.

Mt. Pleasant, Tenn.—Ambrose Lanier can give information concerning organization of company to install an electric-light plant.

Winchester, Tenn.—S. M. Alexander, M. N. Whitaker and George E. Banks are endeavoring to form a company to establish a telephone system.

ELECTRIC HEADLIGHTS.

The master mechanic of the Norfolk and Western Railroad put himself on record recently as being against the electric headlight for locomotives, because, as he asserted, the rays of the light were so strong that it was impossible to distinguish the color of the signal lamps. This statement was promptly challenged by the president of one of the electric headlight companies, and disproved in an actual test at Indianapolis, which was witnessed by several railroad officials.

Many locomotive engineers, however, strenuously object to the electric headlight on another ground—that "running against" it is very dangerous. That is, the stream of light from an approaching locomotive is so powerful that it is practically blinding, and the engineer who faces it cannot tell how far away the approaching locomotive is, or whether it is moving or stationary. Persons who have happened to face a searchlight will appreciate this objection, which becomes especially cogent in the case of single-track railroads.—Tradesman.

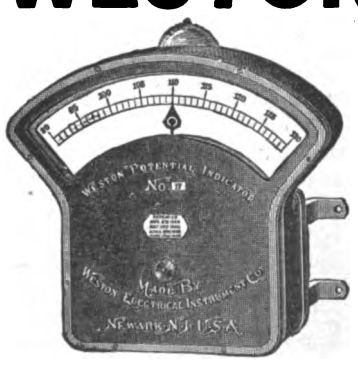
The most important use to which aluminum will be put will be for culinary and household utensils, it being practically incorrodible. It is free from every form of poison and will not taint food; it is light to handle, and is a better conductor of heat than other metals. The recent announcement that contracts had been signed for the delivery in England of 1,000 tons of crude aluminum of American manufacture, makes prominent the fact that this remarkably useful metal is now being produced in this country in large and constantly increasing quantities.

Ten years ago no pure aluminum was manufactured in the United States, and in Europe it was produced at a cost that rendered it valueless to the mechanical world. Today it is the rival, and the successful rival, of both copper and steel. In 1896 the United States alone produced 1,300,000 pounds of the crude metal, a third of the total output of the world. In 1886 the market price of the metal was $1 an ounce; today it is less than 50 cents a pound.

Aluminum is an exceedingly abundant element in nature. It is obtained in the form of an oxide of bauxite, of which there are large deposits in this country.—Power and Transmission.

THE SAFETY INSULATED WIRE AND CABLE Co., mfrs. of Seamless Insulated Wire and Cables, of 229 West 28th street, N. Y., have issued a new catalogue of their unrivalled goods. The catalogue is very handsome, and contains illustrations of plants using Safety wire as well as testimonials from prominent concerns. It is beautifully printed and is well worth preserving.

WESTON STANDARD ILLUMINATED DIAL STATION INSTRUMENTS.



THESE INSTRUMENTS are based upon the same general principle and are just as accurate as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger, and the working parts are inclosed in a neatly designed dust-proof cast-iron case, which effectively shields the instruments from disturbing influences of external magnetic fields.

WESTON ELECTRICAL INSTRUMENT CO.

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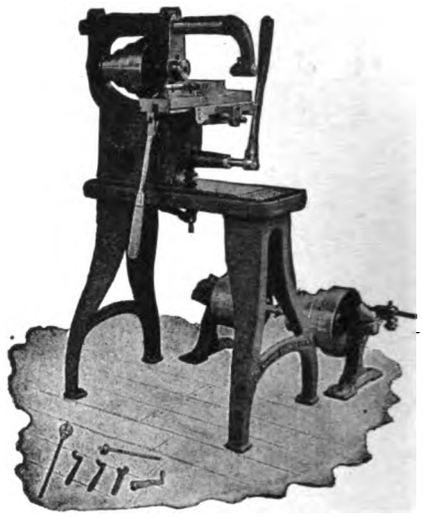

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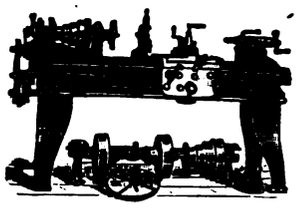

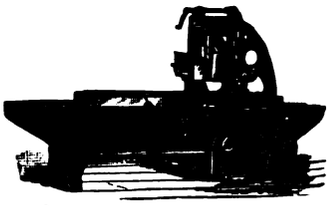

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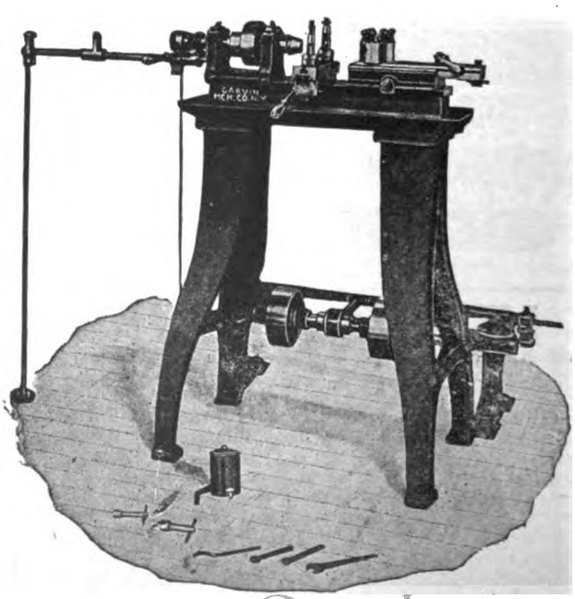

No. 60 SCREW MACHINE (WIRE FEED).

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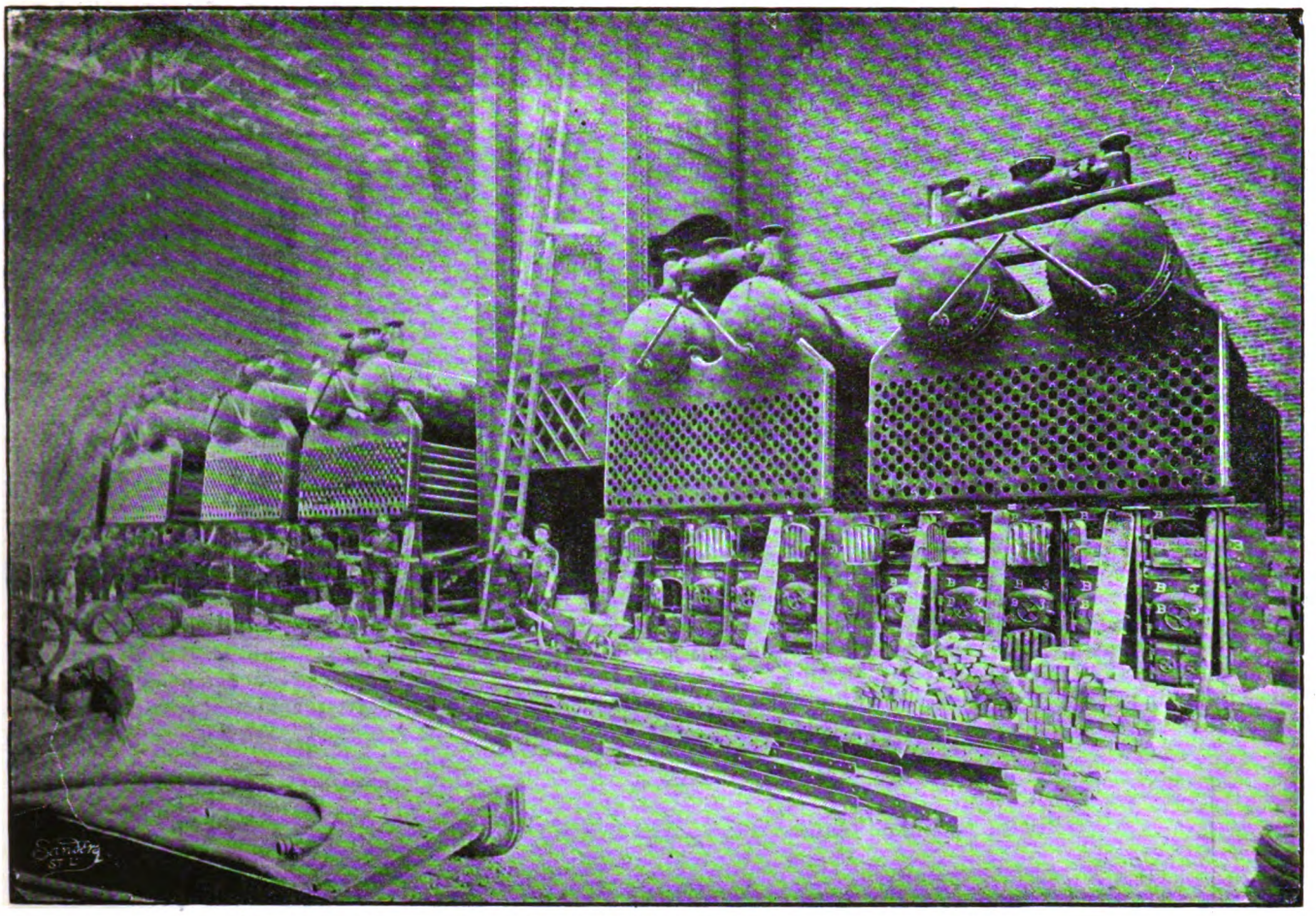
The Electrical Age.

VOL. XXI—No. 10 NEW YORK, MARCH 5, 1898 WHOLE No. 564



The Edison Company's Electric Light Plant. Installing the Down-Draft Furnace.

THE SMOKE PROBLEM.

The problem of burning any grade of bituminous coal and at the same time prevent the emission of soft-coal smoke from the chimneys, as required by the Sanitary Code, has often been brought to our attention by large steam plants where economy of fuel is the great consideration.

After a thorough and systematic investigation of the subject we find that there seems to be no device that will consume soft-coal smoke which has once been formed, or rather that soft-coal smoke, after it once escapes from the burning coals, cannot be consumed, consequently, to obtain the benefits and advantages of soft coal, and at the same time escape the evils of soft-coal smoke, the gases from the coal must necessarily be ignited and burned completely before the constituent elements which compose the smoke are formed.

The down-draft system of burning coals seems to be the only method known at the present time whereby the combustion can be made complete enough to prevent the creation or formation of smoke, and thereby make the burning of bituminous or soft coal practically smokeless.

After the inspection of a number of so-called "smoke consumers" our attention was called to a system in use in the Government Buildings.

We visited the principal Federal Buildings in New York and in other cities where the suppression of smoke is a compulsion.

Our first visit was to the General Post-office, Broadway and Park Row. There we found eight horizontal fire-tube boilers equipped with a device known as the "Hawley down-draft furnace."

When we saw that they were burning soft coal we watched the chimneys for almost an hour. During that time we saw no emission of smoke, except once, when a light vapor, which might have been taken for a puff of steam, came from one of the chimneys and almost immediately disappeared. We then proceeded to inspect this furnace. Upon inspection we found it to consist of an inclined water grate composed of two steel drums about ten inches in diameter, one in the front and one in the back of the grate, their ends extending into and resting in the brick walls on both sides. These drums are connected by a staggered row of water tubes opening at both ends into them. The water grate is connected with the boiler by two water legs, one from the front and one from the back drum, so as to afford a full circulation of boiler water through the grate. Opposite the tubes in the front drum are openings with brass plugs in them, which can easily be removed for cleaning and inspection. About fifteen inches below the water grate is an ordinary cast iron grate. The front of the furnace has three tiers of doors; the upper tier, through which the coal is fed, has two sets of hinges. The space between the back drum and the bottom of the boiler is closed by fire brick, thus forcing the current of air or draft down through the water gate, thereby causing the gases from the coals to pass through a bed of fire, which appeared to us an incandescent mass of about six or eight inches in depth.

We then looked through the middle doors into the combustion chamber and saw a clear flame coming down through the upper grate, passing under the back drum along the bottom of the boiler and back through the

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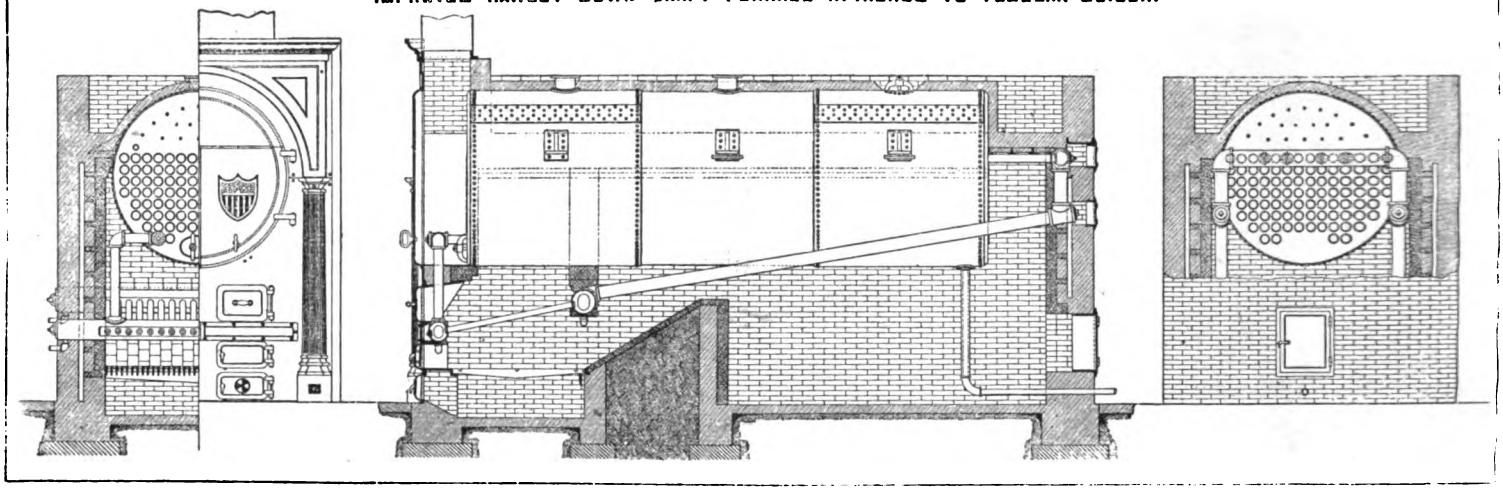
tubes in the usual way. Our informant told us that the smoke is prevented by the gases being ignited in passing through this incandescent mass of hot coals.

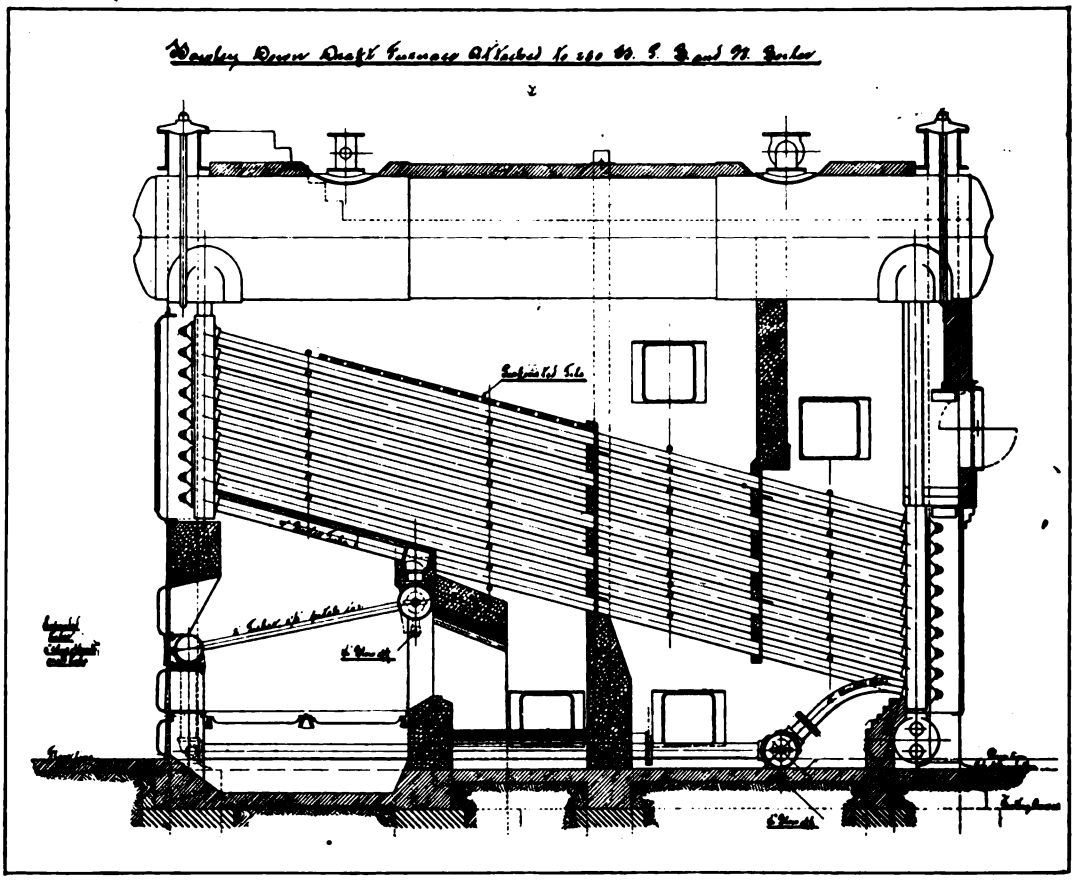
We then visited the United States Custom House on Wall street, where we found four Horizontal Fire Tube

IMPROVED HAWLEY DOWN DRAFT FURNACE ATTACHED TO TUBULAR BOILER.



boilers also equipped with this system and the results the same. On further inquiry we learn that the "Hawley Down Draft" is very well known, and that there are over 4,000 in operation in the United States and Europe. Besides those in use in the principal government buildings we find them also in operation in nearly all the principal water works plants in the United States, and in nearly all of the largest breweries. Those we have communicated with have made most favorable comments, principally as to the material saving in fuel, which seems to be the main object.

The cuts show the water grate and how it is connected with various types of steam boilers.



THE ELECTRICAL EXHIBITS AT THE TRANS-MISSISSIPPI EXPOSITION.

The progress made in electrical science as applied to the uses of commerce, industry, mechanics and the household, will be demonstrated at the Trans-Mississippi and International Exposition. The electrical section promises fully to exemplify the advancement of electrical science, and reveal the highest achievements of discovery yet attained by the genius of invention.

The importance of an exhibition at the Trans-Mississippi Exposition which would combine and practically demonstrate the latest applied uses of electricity was early suggested by the exposition management, which finally led to the creation of a bureau of electricity; Prof. R. B. Owens, of the Nebraska State University, director. The applications for space in this section now on file indicate that

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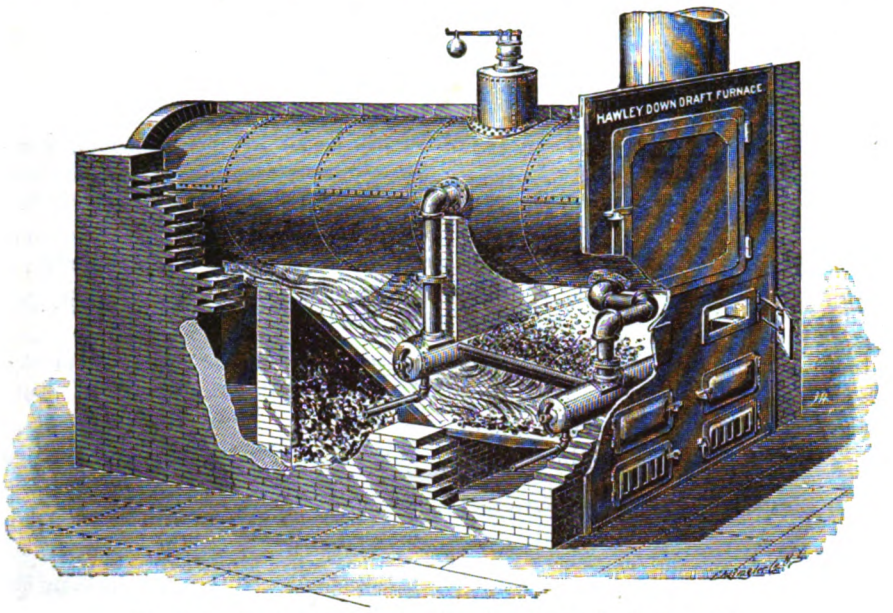
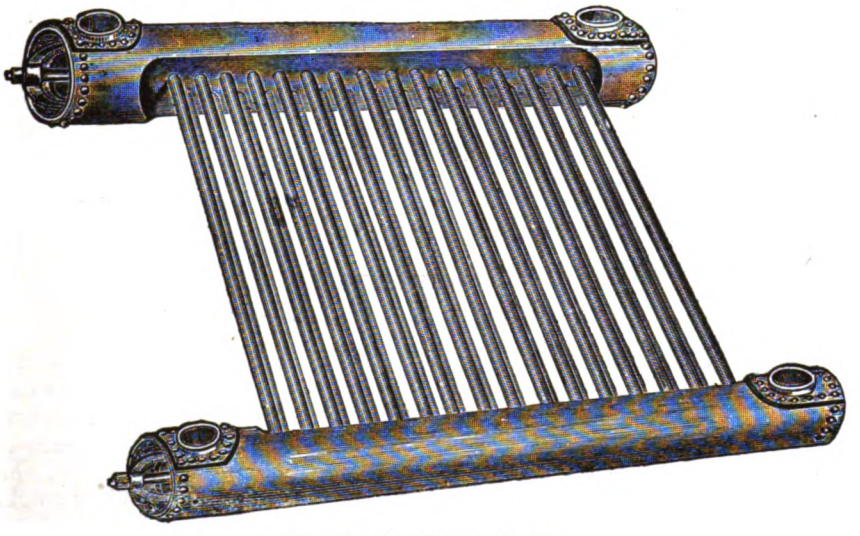
the field of electrical science will be of rare and wide-reaching interest.

THE INVENTIVE GENIUS OF THOMAS ALVA EDISON, the famed wizard of the electrical world, will be shown by a strictly "Edisonian exhibit," now being prepared in his laboratory at Orange, N. J., expressly for the Trans-Mississippi Exposition.

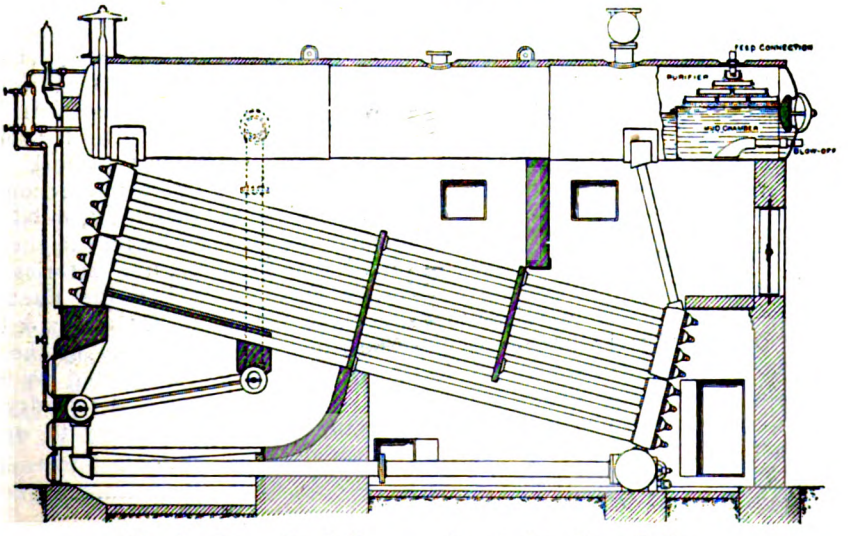
THE SYSTEM OF VACUUM TUBE LIGHTING will be demonstrated for use of collieries and other workings comparatively free from explosive gas. While electricity is a source of heat, this is the nearest approach to the solution of the problem of light without heat.



Showing Combustion in the Hawley Down-Draft Furnace.



The Hawley Water Grate.



Hawley Down-Draft Furnace Attached to Root Boiler.

LIEUT. GEORGE OWEN SQUIER, of the United States army, instructor of military telegraphy and elec-

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tricity at Fortress Monroe, will exhibit his wonderful syncronograph, the new rapid telegraph system invented by Prof. Albert Cushing Crehore, assistant professor of physics at Dartmouth College, and Lieutenant Squier of the War Department. This invention was successfully tested by the inventors on the lines of the British government during the summer of 1897, a distance of 1,097 miles, the rate of speed attained by the syncronograph being three times faster than was indicated by the Wheatstone receiver and transmitter on any line. By the aid of the syncronograph the operator can transmit the contents of an ordinary newspaper inside of an hour's time. Lieutenant Squier will also demonstrate the workings of another of his inventions known as the synocronoscope, intended for the measurement of the velocity of projectiles.

ALL THE RECENTLY DISCOVERED APPLIANCES for use of the army will be shown and illustrated in a practical manner and also the system of military telephones which is calculated to aid the commanding general who directs the operations of an army corps in a future battle. By means of this apparatus, which has been perfected by Captain James Allen of the Signal corps, under the direction of General A. W. Greely, it will be possible to string a line of wire from point to point of an army's communications, and use the same wire for both telephoning and telegraphing.

NICOLA TESLA WILL EXHIBIT the results of several of his latest experiments in electrical science upon which he is now engaged. The abolition of the induction coil for the production of the Roentgen rays will afford ample scope for the exhibition of Mr. Tesla's new electrical oscillator, based upon a discovery made by him several years ago. Diagrams and designs will also be exhibited showing how the Roentgen rays are formed, photographs of wounded soldiers, taken at the seat of the Greek war, an exhibit showing the relation between the atomic weights of metals and their absorptive power, showing that some subtle connection remains to be discovered; a series of zoological subjects, an instrument for photographing solid bodies from two different points of view, which gives the location of the imbedded substance with millimetrical accuracy, together with special tubes, screens and outfits.

TELEGRAPHING AT SEA WITHOUT WIRES will be practically demonstrated by means of the apparatus of young Guzlielmo Marconi, the Italian electrician, who claims to be the inventor of the wireless telegraphy. The singular feature of this method of telegraphing is shown by a wire extended vertically in the air, connected to a radiator on the ground. Messages without wires have been sent a distance of twelve miles to a ship at sea. By simply increasing the height of the vertical wire the influence of the machine can be extended over a distance augmenting in a geometrical ratio to the increased height of the wire. The discovery is yet in its infancy, but it is believed that when completed it will revolutionize present day dispatching and prove of inestimable value.

THE THIRD RAIL SYSTEM, the invention of Captain J. M. Murphy, of Connecticut, will be exemplified by a working exhibit consisting of a line of railway 137 feet in length. By means of a third rail more safety in electric railroad and trolley travel is said to be assured. Cars operated by this system can be reversed under full headway, even on grades and curves, or they may be stopped within one-half of their length. It is entirely feasible under this system to attain a speed of a mile a minute, or sixty miles an hour. The cars in this system carry beneath the seats a series of small storage batteries supplied from the feed current. The cars are heated and lighted from the electricity thus stored.

A system for alternating the current of street railway motors will be shown.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The 122d Meeting of the Institute was held at 12 West 31st street, February 23, and was called to order by President Crocker, at 8:30 p. m. About seventy-five members and guests were present. A paper on the "Single Phase Induction Motor" was read by Mr. Steinmetz and was discussed by Prof. W. S. Franklin, Dr. A. E. Kennelly, Messrs. E. E. Ries, Townsend, Wolcott and others.

At the meeting of the Executive Committee, in the afternoon, the following Associate Members were elected:

Frank Broili, electrical engineer, California Elec. Works; residence 823 Geary street, San Francisco, Cal.

Samuel Byington Libby, supt. N. Y. & S. I. Electric Co., West New Brighton, N. Y.

Otto T. Louis, manager of New York Branch, Queen & Co. inc.; residence, 340 East 119th street, New York City.

James A. Mortland, Prof. of Physics, Faculty State Normal School, 2502 Walnut street, Cedar Falls, Iowa.

Charles H. Schum, electrical engineer, Ideal Electric Corps, 216 Third avenue, New York City.

C. E. Sedgwick, agent at San Francisco office, General Electric Co., 15 First street; residence, Berkeley, Cal.

Mr. William Coltz, of Milwaukee, was transferred to full membership.

P. S.—Copies of Mr. Steinmetz's paper will be sent for publication upon request.

Respectfully,
Ralph W. Pope, Secretary.

NEW STANDARD OPEN CIRCUIT DRY BATTERY OFFERED TO SECRETARY LONG OF THE UNITED STATES NAVY.

Mr. William Roche, the expert dry-battery manufacturer of 259 Greenwich street, New York, offers the use of his standard dry batteries of special design to Secretary Long. The style of battery designed for naval or shore service is 2½ inches high, one and nine-sixteenths across the oval and one inch in thickness, and Mr. Roche guarantees 1.30-100 volts at four amperes discharge. The cell weighs about one-quarter of a pound, and fifty of these little cells are guaranteed to discharge any style or kind of bomb or mine. Secretary Long can have any quantity of these little cells he desires at short notice.

The Standard Dry Battery is the production of Mr. William Roche, of 259 Greenwich street, N. Y. Mr. Roche has made dry batteries for the past nine years and his ability to place upon the market a dry battery of exceptional quality is universally recognized. He claims the "Standard" is the strongest, quickest to recuperate and the most durable dry battery in the market.

Mr. Roche made the dry batteries that were sent to the World's Fair, and called the Exeter dry battery, and were made for the E. S. Greeley & Co., and selected as the best out of 200 exhibits by the board of 200 expert electrical engineers appointed by President Cleveland. It will be remembered that this dry battery was used in connection with a Victor key to open the World's Fair by President Cleveland.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS has decided by recent council action to meet in Omaha the coming summer. The institute numbers over a thousand members and is the representative electrical engineering organization in America.

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TEST OF NASH GAS ENGINE, WITH DIRECT-CONNECTED DYNAMO.

Graduation Thesis, 1897, by Fred Ophuls, William I. Thompson and H. Donald Tiemann, at the Stevens Institute of Technology, Hoboken, N. J.

Description of Plant.

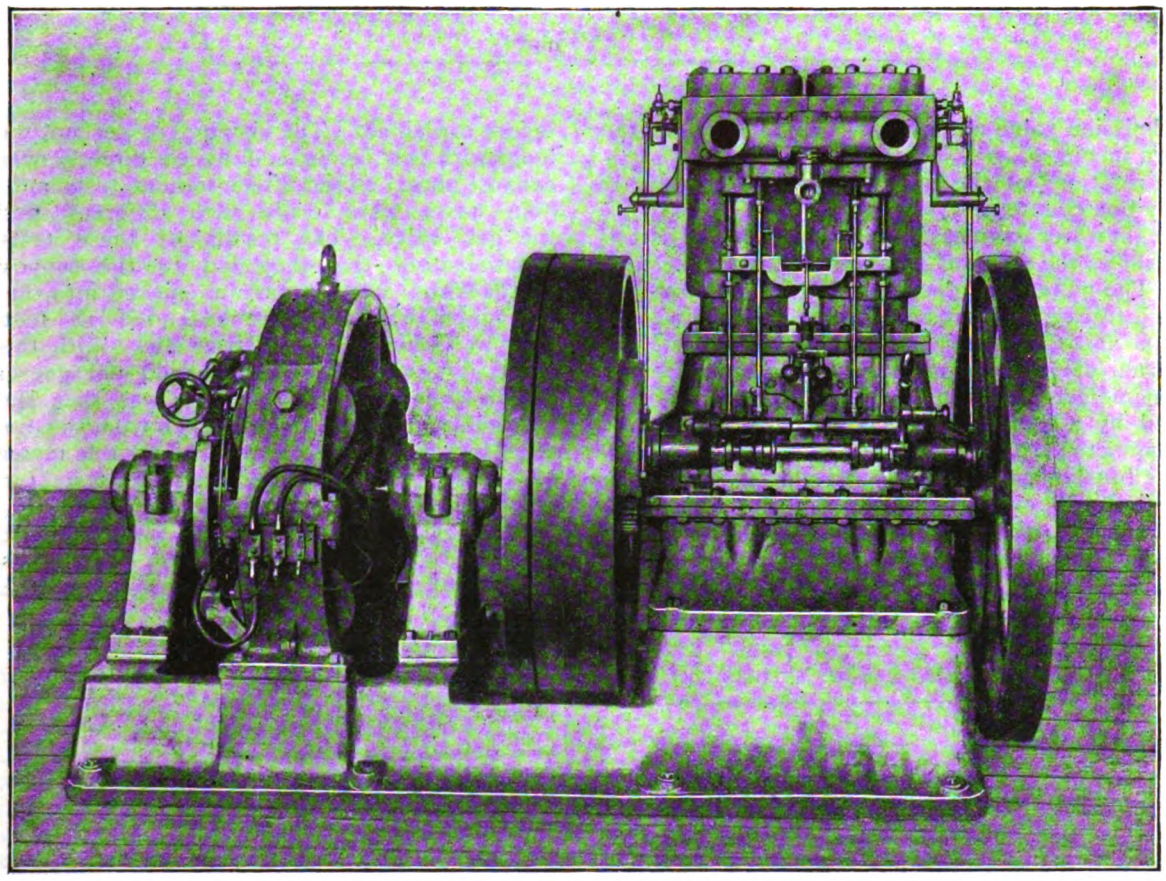
The plant tested is one that was presented to Stevens Institute of Technology by members of the Board of Trustees, the Faculty, and the class of '97. It is located in the Electrical Laboratory. It consists of a 20 h.-p. Nash Gas Engine, coupled by means of a friction clutch to a Riker dynamo. See Fig. 1.

The engine is of the vertical type. The base is a heavy casting, forming an enclosing case, in which are placed the crank shaft, bearings, and connecting rods, all of which are run in oil, and are accessible through a large door. There are two single-acting cylinders, entirely independent of each other, with cranks set at 180° apart, so that two explosions occur in alternate revolutions. The governor is a simple disengagement-governor, one rod being set slightly in advance of the other, thus allowing, at times, an admission in one cylinder only, which renders the governor more sensitive. The valves are of the plain poppet type and are actuated by hardened steel cams on a counter-shaft, making one-half the revolutions of the main shaft. On this counter-shaft are also the two eccentrics for operating the electric igniters, the time of explosion being regulated by the position of the eccentrics. Besides these there are hot-tube igniters, consisting of tubes heated red-hot by Bunsen burners.

The gas is admitted to the engine by an adjustable check valve. It passes up through a circular hole in the valve seat. over which rests a flat washer, which acts as a check to the return flow of the gas. As the gas passes through, it lifts the washer from its seat, the amount of lift being regulated by the screw-cap of the valve. The rim of this cap is indexed, so that its position may be noted, and the flow of gas regulated.

The dynamo is a six-pole compound-wound machine built by the Riker Electric Motor Company, of New York; it is rated at 125 volts, 120 amperes, and 300 revolutions.

In order to secure as nearly a uniform speed as possible for the dynamo, it is not fixed directly upon the shaft of the engine, but is coupled by means of a friction clutch. This consists of three separate wheels: the engine fly-wheel, upon the inner surface of which the friction shoes act; an intermediate fly-wheel, which is not fast to either shaft; and a smaller, inner wheel, which is fixed to the shaft of the dynamo. When the engine speeds up suddenly, the two shoes attached to the intermediate wheel are thrown off by the centrifugal force of two weights, thus allowing this wheel to lag. The lag, by a system of links, in turn loosens the four shoes connected to the dynamo wheel, thus disconnecting, to a degree, the dynamo from the engine. As the dynamo has less momentum than the intermediate fly-wheel, especially when running under a load, it will immediately tend to lag behind this wheel, the effect of which is to tighten the shoes of the dynamo wheel against the engine fly-wheel until its speed is brought up to that of the intermediate wheel again. As the intermediate wheel loses momentum its shoes again tighten to the engine wheel, and its momentum is restored. Thus the speed of the dynamo is controlled by the action of this intermediate wheel.



200-Light Direct-Connected Nash Engine and Dynamo. Fig. 1.

Synopsis of Tests.

A. Comparison of illuminating power obtained from
1. Most efficient conditions for running engines.
2. Tests of electric output.
3. Photometry.

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B. Friction of engine and dynamo.
C. Prony brake test of engine.

Description and Arrangement of Apparatus.

The gas for the engine was measured by a 100-light meter, built by John J. Griffin & Company, of Philadelphia, and that for the igniters by a small 5-light meter, built by the American Meter Company, of Philadelphia.

The number of admissions of gas was registered by a recording ticker, electric contact being made every time either admission valve was raised. Samples of the tape are shown in Fig. 2.

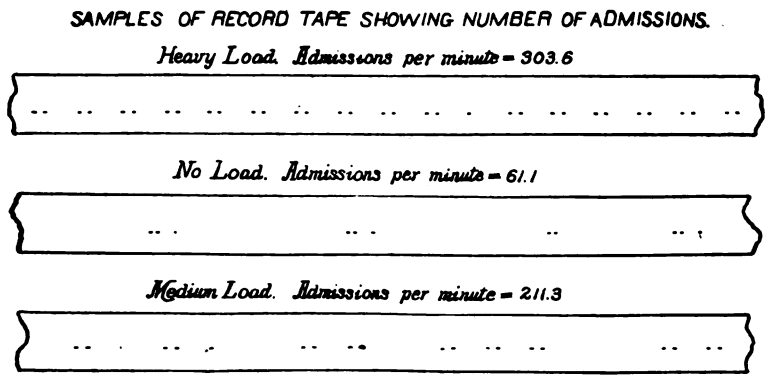

Fig. 2.

The revolutions of the engine and dynamo were recorded by box counters.

The jacket water was measured in two calibrated barrels.

Fig. 3 shows the general arrangement of the electric circuit. The power was distributed from two bus-bars, B, through fuse wires, part being absorbed by incandescent lamps and the remainder in a water rheostat, R. The external current was measured by an ammeter, A, and a dynamometer, D, in parallel, and the current in the shunt field by a dynamometer, D_1. The voltmeter, V, was so connected that the volts could be measured both across the brushes directly and across the terminals of the external circuit by changing the switch, S. The instruments, A, D and V, were placed about 20 feet from the dynamo so as to insure their being out of any field. The ammeter, A, showed no error, and the voltmeter, V, showed a possible error of 0.2%. The dynamometer, D, was not tested for field, but as its position was similar to the ammeter, A, it is fair to presume that it, also, was not affected. The dynamometer, D_1, was affected by a field to the extent of 4%. Since the instruments were always placed in the same positions, any errors due to field may be neglected in the comparative tests where the load is not very different.

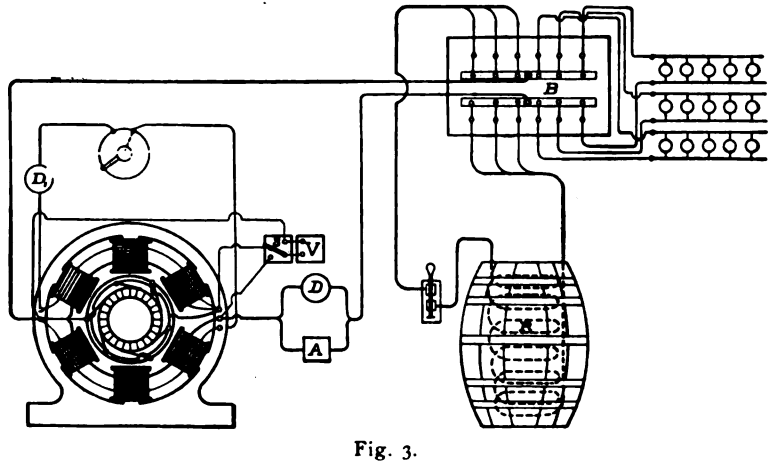

Fig. 3.

The water rheostat was made of about 40 feet of No. 14 B. & S. German silver wire, wound upon a wooden frame and immersed in a barrel of running water. It absorbed between 9,000 and 10,000 watts.

Description of Tests.—Test A.

1. Before comparing the illuminating power of the gas and electric light, it was of the greatest importance to ascertain the conditions under which the maximum output was obtainable for the least consumption of gas. The most natural element to vary with this end in view (after setting the brushes of the dynamo in the best position) is the amount of gas admitted with the air to each cylinder, which is regulated by the position of the gas valve, as before explained. The air pipe, as set up, was 21 feet long, with two bends, and ended directly over the two exhaust pots. Seven fifteen-minute tests and five one-hour tests were made with different positions of the gas valve. The results of these tests were so unsatisfactory that they led to the supposition that at times the exhaust gas was sucked into the air pipe. The pipe was therefore extended 18 feet horizontally in order to obtain pure air. With this arrangement, however, the engine could not get enough air to run under a load. The pipe was then shortened to 6½ feet, so that the air was taken from the room, and a short test made which gave a remarkable increase in the efficiency. It was decided to make tests for the best length of air pipe, varying the position of the valve for each length. Forty-three (43) twenty-minute and five (5) fifteen-minute tests were made. In all these tests the temperature of the jacket water was kept the same, as nearly as possible.

2. Having thus determined these two factors, two four-hour tests for the electric output were made, one with a medium load, the other with the greatest load the engine would carry.

The method of carrying out these tests was as follows: Readings were taken every 3 minutes in the fifteen-minute tests, every 4 minutes in the twenty-minute tests, and in the long four-hour tests, every 5 minutes. The readings taken regularly were:

Gas Meter.
Temperature of Gas.

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The Electrical Age.

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NEW YORK.

NEW YORK, MARCH 5, 1898.

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ELECTRICITY FOR ELEVATED RAILWAY SERVICE.

Many prominent engineers consider the elevated railway structures of New York and Brooklyn ideal places for the installation of an electric railway system. The fact that the tracks are raised above the street level to such an extent as to allow the installation of a third rail, block automatic or trolley system, means freedom from all possible sources of trouble generally met with in an ordinary street system of electric railroading. The great advantage of electricity as a motive power on elevated railways has been seriously considered by the Manhattan Railway Company, of New York, and the Brooklyn Elevated Railway Company, of Brooklyn. One of the daily newspapers in the Feb. 24th issue, makes note of the following: "contracts were let to the Sprague Electric and Walker Electric Companies yesterday, for an electric equipment of the Brooklyn elevated cars. . . . The contracts were let at a meeting of the Brooklyn Elevated directors yesterday, at which were present representatives of both the electric companies. The directors of the elevated company said they believed the adoption of the motors would be the salvation of the elevated roads and would in a measure solve the rapid transit problem, as it has been shown that the motors can attain fifty per cent. greater speed than the steam engines at much less expense. The cars are to be equipped with the Sprague system of multiple units control, recently adopted by the South Side Elevated Railway Company, in Chicago, and also with motors made by the Walker Company."

The above communication is interesting to the people of Greater New York, because the introduction and use of electric power on the elevated roads would mean a clean sweep and continuous circuit from the Harlem suburban district, over the bridge and out to Coney Island. Rapid transit would become an immediate possibility from any point in Brooklyn to any desired spot in New York. The above subject has been well treated by S. H. Short, in a pamphlet published by the Walker Company, of Cleveland, O., and the opening paragraph of his article reads: "the elevated railways of New York, Brooklyn and Chicago were built to satisfy a crying demand for rapid transit from the business centres to the suburban districts of these great cities. . . . Since the trolley car has come into general use people have been educated to a still more rapid rate of travel and where the trolley car parallels the elevated railroad, as in Brooklyn and Chicago, the frequent speed and accessible surface car is by far the most popular. . . . In order to retain their traffic it will be necessary for elevated railways to move their trains more frequently and at a much greater rate of speed to compensate the travelling public for being obliged to walk some distance and climb those disagreeable stairs."

The heavy traffic which is met with in the Metropolitan district at six o'clock in the evening and eight in the morning would certainly necessitate the use of reliable apparatus. An examination of the starting periods of trains at stations seems to show that a great number of locomotives begin moving at the same time. The call for power upon a station would therefore be very heavy for a few moments, and possibly the power station would be very much larger than it would be were the times of starting coincident only to a slight degree. Such details as these, however, could be very well attended to by an able electrical engineer, and the load upon the station, even when the heaviest traffic prevails, so distributed as to prevent any sudden strain from occurring upon the central power plant. A third rail installation upon an elevated railway structure would certainly become part of an ideal system. There is no better place conceivable than on an elevated support, "far above the madding crowd," for the success of an electric system, the cars of which would be brilliantly illuminated, and whose rate of acceleration would mean the rapid transportation of passengers to their homes without delays, transfers and other disagreeable features of the present steam locomotive system.

With good light and high speed and a belt line reaching from the Atlantic Ocean to the Harlem River and beyond, the people of Greater New York would feel that their wants have at last been attended to and the misery of travelling back and forth at a snail's pace obviated. It may take sone time before the corporations controlling the elevated roads fully listen to the public demand, but that time is not far off, and then the use of steam locomotives within the city's limits, with their dirt, smoke and noise, will soon become a matter of history.

A FITTING EXHIBITION FOR THE CLOSING CENTURY.

The great development of electrical industries has brought people to the belief that the use of electricity plays an important part in the arts and manufacturing methods known at this present period. The exhibition about to be given in Madison Square Garden in May will include within its scope kindred industries as well as those electrical. It will show the general public what progress has been made in recent years and bring within their comprehension a little corner of each of its manifold branches.

Electrical industries have so magnified within late years that it has become necessary for those undertaking the management of this exhibition to select as large a place as possible in order to do full justice to the great list of exhibitors whose goods and electrical devices will be on view. The most novel types of mechanism, the most improved types of power generating machines and the most interesting application of electrical principles will be demonstrated and shown to the thousands marveling at the wonders around them.

The undertaking of the Electrical Exhibition Company is one of great responsibilities, and we congratulate them thus far upon the success that has attended their efforts.

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Pressure of Gas.
Temperature of Room.
Field Current.
External Current.
Volts Across the Brushes.
External Volts.
Revolutions of Engine.
Revolutions of Dynamo.
Quantity of Jacket Water.
Temperature of Jacket Water.

The admissions were taken often enough to obtain a reliable average. The barometer readings were also taken.

The energy absorbed in the field was considered with the external output, before comparing the results of the preliminary tests.

All volumes of gas were reduced to 30 ins. Hg. and 60° F. by means of table Pg. 212, Vol. 13, of the Stevens indicator.

The calorific power of the gas was determined by means of the Junker calorimeter.

to 30 ins. Hg. and 60° F. by table Pg. 212, Vol. 13, of the Stevens indicator.

Test B.—Friction of Engine and Dynamo.

The method of finding the friction was to drive the engine and dynamo with no load by means of a separate motor belted to the engine pulley, and afterwards to calibrate the motor by a Prony Brake under the same electric conditions. The currents for the field and armature were supplied by separate machines, the field current remaining nearly constant during the tests. The mechanical friction of the engine could not be found with the cylinder heads on, for the engine acts as an air pump. One test was made with the heads on and two with the heads off, the revolutions of the engine being the same as when running itself.

Test C.—Prony Brake Test of Engine.

For this test the dynamo was disconnected and the consumption of gas per brake h.-p. was determined for the heaviest load.

TABLE I.

CANDLE POWER OF GAS.

Kind of Burner.	Gas per hour, cu. ft.	Candle Power.	C.P. per cu. ft. per hour.
6	5.39	28.62	5.31
4′	4.05	14.72	3.634
3′	2.94	9.08	3.088
		Average =	4.01

CANDLE POWER OF ELECTRIC LAMPS.

Condition of Electric Lamps.	Watts.	Candle Power.	Watts per C. Power.	Average.	C.P. per Kilowatt.
New.....	61.3	16.12	3.803	3.66	273.2
"	62.0	16.57	3.742		
"	59.4	17.27	3.44		
Medium	49.6	10.45	4.75	4.77	209.6
"	58.1	12.15	4.78		
Old	48	7.47	6.42	6.42	155.8

	Medium Load.		Heavy Load.	
	Not including gas for igniting burners.	Including gas for igniting burners.	Not including gas for igniting burners.	Including gas for igniting burners.
1. Gas per Kilowatt per hour.—cu. ft.....	33.12	33.99	30.26	30.84
2. C. P. of Gas required to produce 1 Kilowatt = (1) × 4.01.....	132.8	136.3	121.3	123.7
3. Ratio of light for same amount of gas consumed with flat flame gas burner.* = Electric / Gas — New electric lamp....	2.06	2.00	2.25	2.21
Medium " "	1.58	1.54	1.73	1.69
Old " "	1.17	1.14	1.28	1.26

3. The photometer used was a Bunsen photometer. In order to avoid any differences in the illuminating power of the gas, all the photometric measurements were made on one day. The gas flames and the electric lamps were each compared with an Argand burner, which was first standardized by means of spermaceti candles. In standardizing this burner, all tests were rejected in which the two candles did not burn at the rate of 40 grains in from 9½ to 10½ minutes. The candle-power of the standard burner did not affect the relative candle-powers of the lights compared. Therefore any error in finding the candle-power of the burner by means of the candle may be neglected.

The lights compared were: six electric lamps, and a 3-foot, 4-foot and 6-foot gas burner. They were measured at various angles, the average of these readings at each angle being taken. The gas was measured by a 5-light American gas meter, and the readings were reduced

In order to determine the most efficient air pipe length, and valve position, forty-one hour tests with a 21-foot pipe and forty-eight comparative tests on various air pipes and valve positions were made.

The best conditions were determined to be, 3-foot pipe and 7½ valve position, which are therefore used in all following tests.

Two four-hour tests were made to determine the gas consumption per kilowatt per hour, which was found to be, for a medium load:

33.12 cu. ft., not including gas for igniting burners, and

33.99 cu. ft. including gas for igniting burners;

and for a heavy load:

30.25 cu. ft., not including gas for igniting burners, and

30.83 cu. ft., including gas for igniting burners.

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Standardization of Argand Gas Burner With Edgerton Slit, Used for Measuring Candle-Power of Gas Flames and Electric Lights.

The candle-power of the candles was calculated by the formula:

$$\frac{\text{Candle-Power}}{2} = \frac{150 \text{ seconds}}{\text{Time required to burn 10 grains, in seconds}}$$

in which 150 seconds is the standard time for 2 candles to burn 10 grains when giving 1 candle-power each, which corresponds to one candle burning at the rate of 2 grains per minute.

x = distance in inches from standard Argand burner to screen.

$100 - x$ = distance in inches from candles or gas flame to screen.

The candle-power of the burner was calculated by the formula:

$$\frac{\text{Candle-power of Burner}}{\text{Candle-Power of Candles } x} = \frac{}{(100 - x)^2}$$

and was found to be 6.4.

The candle-powers of the gas flames were calculated by the formula:

$$\frac{\text{Candle-Power of Flame}}{6.4} = \frac{(100 - x)^2}{x^2}$$

The candle-power was measured for the flame in twelve positions 30° apart, the position when the flat side of the flame was toward the screen being called 0°.

(To be continued.)

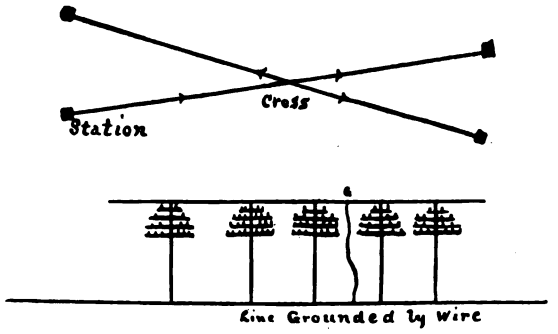
Eureka Springs, Ark.—The Citizens' Electric Co. has been incorporated by W. M. Duncan, president; A. R. Sayle and L. P. Badger, to operate plants for electric light, etc. Capital stock, $25,000.

THE TESTING OF LINES.

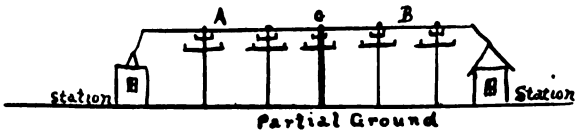
LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

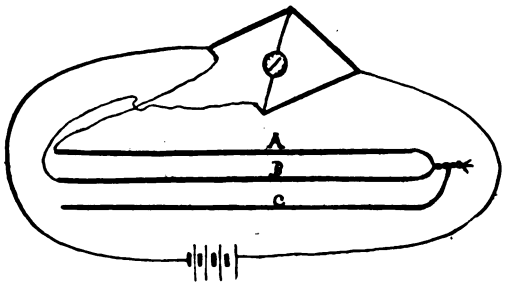
BY NEWTON HARRISON, E. E.

Entire freedom from crosses and grounds on a line is secured by constant attention, regular testing and inspection. When a line is crossed with another line the signals sent over the first do not reach their destination but affect the sounder of some other station not supposed to receive the impulse.



Crosses.—Not only may this occur but the current may return to a ground circuit, if the cross brings it into contact with such, and also become lost, as in the first case. Crosses therefore may be looked upon as causing a straying of signals, or possibly their complete disappearance. The location of a cross is made by testing the line. Should its resistance be greater or less than is usual the trouble is at once indicated, but not its nature. A ground is likely to assume the same appearance as a cross when superficially tested. A cross can therefore be discovered by the fact that the resistance of the line has changed, and also by a lack of signals at the other end. Each station has its own peculiar signal to receive when communications are to begin with any other. A cross may thus create a disturbance in either one or more lines, and by a resistance test be located. When a difficulty of this kind occurs with an electric light line a set of fuses will blow and save it. A source of trouble that is very irritating to a telegrapher, and which fortunately occurs very infrequently, is the swinging of telegraph or telegraph or telephone lines. They may touch for a long while when the wind blows, or only occasionally, causing a temporary cross or ground which when looked for disappears to return at odd moments. Swinging crosses or grounds are best removed when the line is at rest; the early morning or evening, or whatever time allows for such investigation. The loss of conductivity in a line may be traced to several causes. One of the most common is poor connections, etc. If a line is free from all difficul-





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ties, length should represent a definite resistance when tested. The tests made for conductivity are simple; they differ from those made for insulation resistance in degree merely, in all other respects being identical.

Breaks.—A break in a line necessarily destroys all means of communication with the other end, unless the broken portion lands in a brook or on another line. If the ground connects the broken end, a test made of the resistance of the line will disclose the fact that it is incomplete. If the resistance of contact is high, the familiar features of partial ground manifest themselves without, however, any signals being received at the other end at all.

Grounds.—When the line falls into contact with the earth it is likely to do so in two ways; they are spoken of under the following heads:

Dead grounds,
Partial "

Dead grounds.—A dead ground is so called when the contact between the earth and the line is electrically good. A pole may be decayed inside, saturated with water and practically ground the line as well as if a plate were used. The pouring rain may stream down the pole, or a collection of them, and cause a dead ground. In this case the signals cannot possibly reach the other end, but return home through the faults. A wire hanging from the line to the earth and touching a grating or a cornice, or even piping of some description, produces this defect. Its location is found by measuring the resistance of the line. If, for instance, the normal line resistance = 100 ohms and the test shows only 80 ohms, the ground exists at a point $\frac{8}{10}$ of the distance from the station; this, remember, is based upon the supposition that the line is dead grounded at that point. In making the test, one end of the line is connected to the Wheatstone bridge and the other end leading from the ground plate also to the Wheatstone bridge. The circuit is now complete through the line, dead ground, earth and Wheatstone bridge. The resistance of that portion of the line in contact with the earth and between the ground and the station is thus found. Its resistance in ohms represents an equivalent in feet. It may be 10 ohms per mile or 100 ohms per mile; in any case, this data determines its position.

Partial grounds.—This common fault develops due to many cases, such as contact of the wire with a tree, or the leakage due to very poor insulation at any given point of the line.

In testing a line for a partial ground the position of the leak is determined by a double test. Calling one telegraph station A and the other B, the line between would be called A B. The ground G is of a resistance that in each test is included with the resistance of that part of the line from which the test is made. In measuring the resistance of the line from A, the circuit is opened at B. Therefore, the resistance measured is equal to that through A and G back to the station. This being done the line is opened at A and tested from B; the resistance is measured through the B portion of the line and C.

Test (1) resistance = A + G.
" (2) " = B + G.

The rule employed for finding the position of the ground from A and from B is as follows:

Resistance of A portion of line =

$$\frac{\text{Resistance of test (1)} + \text{resistance of (A + B)} - \text{resistance of test (2)}}{2}$$

or conversely the resistance of B portion of line =

$$\frac{\text{Resistance of test (2)} + \text{resistance of (A+B)} - \text{resistance of test (1)}}{2}$$

The resistance of the entire line is known either by its length in miles of a given size of wire, or by a resistance test.

Taking a case in practice as follows: A line is grounded and a test made from each end through the ground with this result:

Test (1) from A through ground = 1075 ohms.
" (2) " B " " = 1025 "

To find the number of ohms the ground occurs away from either A or B, the rules are applied and, when the ohms are known, the distance is understood.

If the line had 10 ohms to the mile its location would be (if the line has 100 ohms resistance)—

$$\text{From A} = \frac{1075 + 100 - 1025}{2} = 75 \text{ ohms.}$$

$$\text{From B} = \frac{1025 + 100 - 1075}{2} = 25 \text{ ohms.}$$

At 10 ohms to the mile the ground is

7.5 miles from A.
2.5 " " B.

This test applies equally well to telephone, telegraph and electric light lines.

The cross talk on telephone lines is due to the electromagnetic or electrostatic induction occurring.

The electrostatic seems to be the most effective in producing the trouble so familiar to all. The remedy for this is applied by twisting the wire; the inductive action being neutralized throughout by this means.

Covering the wire with an iron inductive coating of the best possible description will tend to reduce this difficulty to a great extent. At times the most novel practices are employed, such as surrounding the wire with crimped paper, etc. This is done to embody as much air as possible in the covering; air having a less inductive capacity than other materials, and therefore prevents induction to a considerable extent.

The usual tests made of a line bear reference to its

Conductivity,
Insulation,
Capacity.

A sensitive galvanometer and a bridge will enable these tests to be successfully made.

Conductivity of one wire.—This is found by grounding one end and allowing the other to go to the arm of the bridge, measuring the unknown resistance, and then to the earth. The earth resistance being zero, the line may be measured.

Conductivity of a line by means of another.—If two lines lie side by side they may be measured without grounding, provided they be of equal gauge. Their extreme ends are twisted together and the other two ends connected to the bridge arm. The total resistance measured divided by two will equal the resistance of either.

To measure the conductivity of three lines.—If three lines of the same or unequal resistance are side by side, and the resistance of each respectively is to be found, three tests are essential by this method.

Calling the three lines A, B and C, the three tests take in the combined resistances of A and B, of B and C, and of A and C. This is obtained by joining their ends all together, leaving the three other ends free for the tests.

tests (1) resistance of A + B
" (2) " " B + C
" (3) " " A + C

The rule to be applied is then as follows:

$$\text{Resistance of A} = \frac{\text{test (1)} + \text{test (2)} + \text{test (3)}}{2} - \text{test (2)}$$

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$$\text{Resistance of B} = \frac{\text{test (1)} + \text{test (2)} + \text{test (3)}}{2} - \text{test (3)}$$

$$\text{Resistance of C} = \frac{\text{test (1)} + \text{test (2)} + \text{test (3)}}{2} - \text{test (1)}$$

The last is not necessary, as C may be found by subtracting A and B from

$$\frac{\text{test (1)} + \text{test (2)} + \text{test (3)}}{2}$$

To illustrate this case

$$\text{test (1)} = 110 = A + B$$
$$\text{“ (2)} = 130 = B + C$$
$$\text{“ (3)} = 100 = A + C$$

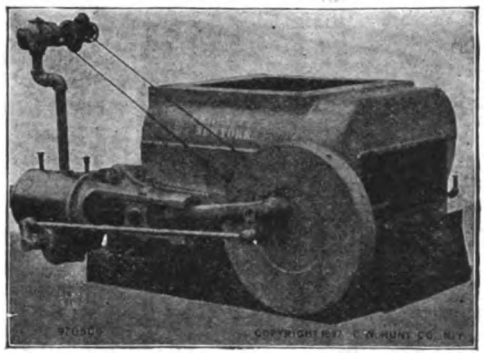
$$\frac{\text{test (1)} + \text{test (2)} + \text{test (3)}}{2} = 170 \text{ ohms.}$$

Then A = 170 — 130 = 40
B = 170 — 100 = 70
C = 170 — 110 = 60

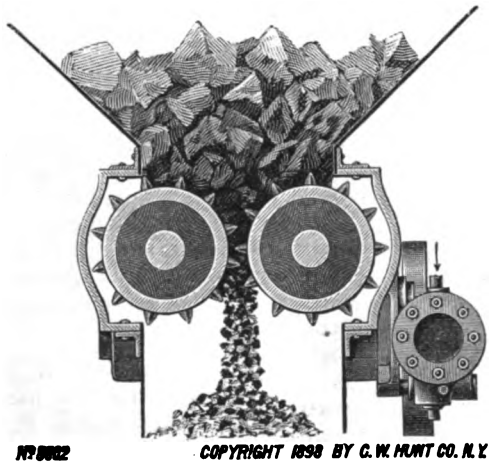
Thus the resistance of lines may be determined irrespective of their size by this method.

THE HUNT COAL CRACKER.

The Hunt coal cracker is designed for breaking the large lumps in run of mine of bituminous coal into smaller pieces that will feed through the automatic stokers used under the boilers of large steam generating plants. It is believed by many engineers who use hand firing, both in stationary and in locomotive boilers, that it is advantageous to break the larger lumps of coal into smaller sizes, both on account of the easier and more perfect distribution of the coal on the grates by the fireman and a more perfect combustion resulting from an evener fire.

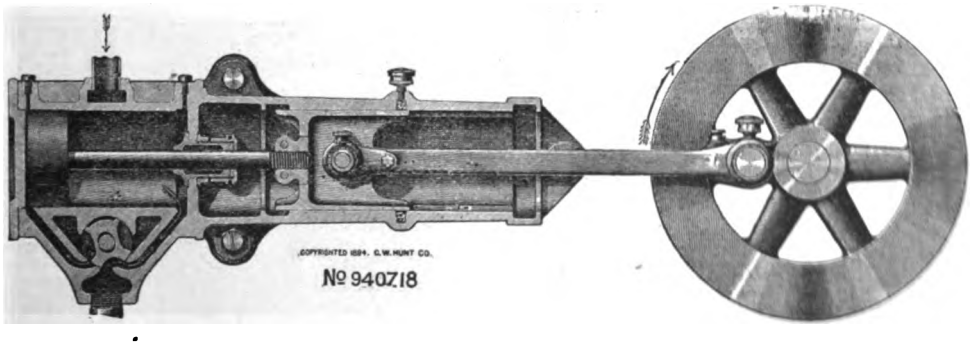


Cracker Driven by Direct-Connected Steam Engine.



The points on the rolls are made of tool steel with hardened points, especially designed to crack and not to crush the lumps of coal so that none of the advantages of lump coal are lost. The fine coal passes through the rolls unaltered.

The cuts show the cracker driven by a direct-connected steam engine having the steam ports and passages all draining continuously downward, the steam entering at the top of the cylinder and the exhaust passing out at the bottom, so that all condensed water is immediately drained off, and every drop of the water from cylinder condensation is swept out of both the cylinder and ports at each stroke of the piston, thus materially reducing the cylinder condensation. In starting there are no pockets



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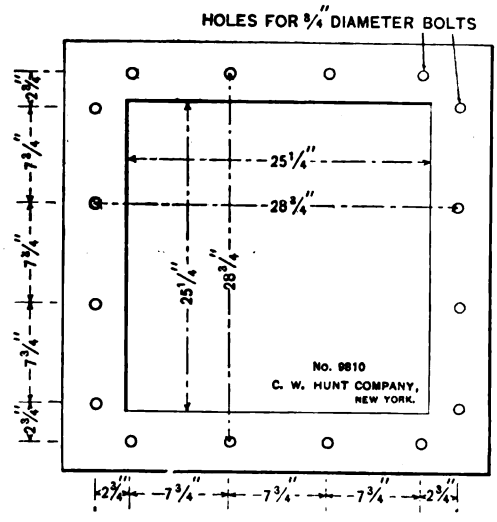
of water to plunge forward and endanger the engine. There is no danger from frost, even in zero weather.

The cross-head bearing on the slide is made longer than the stroke of the piston (see cut No. 940718) so that it will not uncover a central oil well, packed with an elastic absorbent packing, that keeps the sliding surface constantly swabbed with oil. The bearing is unusually wide, so that the bearing on the slide is about four times the area generally used in commercial engines.

The rolls are made the proper diameter to break the coal to the size required, and are not adjustable in the frame, thus eliminating all elements that might be sources of weaknesses and delays. Both the gearing and the rolls are entirely enclosed, each in a separate compartment in a cast-iron frame. This prevents the coal dust from entering either the bearings of the machinery, the gear box, or the room in which the breaker is located. The gearing is easily accessible, but entirely inclosed and protected from dust while running. The gearing run in a bath of oil, that insures perfect lubrication. The vertical distance between the feeding hopper and the delivery spout is reduced to a minimum, as the space available for the cracker is usually limited. A horizontal spindle governor is adjusted in position and so located as not to interfere with the feeding hopper. The breaker may be placed below the hopper under the railway car track so that the coal feeds directly from the car through the rolls into a conveyor which transports it to the storage bins. When coal is hoisted from a vessel the breaker is usually put under the hopper into which the coal buckets dump.



Cut No. 9810 shows the exact distance of the bolt holes in both the top and the bottom flanges of the cracker, which are given here in order that engineers can design and construct the coal hoppers and spouts that will fit the cracker when ordered. The cracker can be bolted directly underneath the lower part of the hopper, or supported on the top of the spout or in any other manner that may be convenient.

While the average horse-power consumed by a coal breaker is small, the necessity for strong and perfect construction of the parts under stress must be evident. The axles in the rolls are of steel, large in diameter, and the frame is of massive construction to resist the great and sudden strains that may come upon it, especially when some foreign substance accidentally falls in the rolls while running.

These machines can be used to advantage for breaking other hard substances, the rolls in such cases being made to suit the work.

The breaker is self-contained and ready to run when placed in position, thus saving the framing and erecting expenses frequently required with machinery that is not so complete in itself.

The breakers are either in stock or in process of construction, and a prompt delivery can be made for standard sizes that break the coal to suit automatic stokers or hand firing. Rolls will be made to order for other sizes.

An electric motor or power from ordinary shafting can be used instead of the steam engine.

Shipping weight about 7,000 lbs.

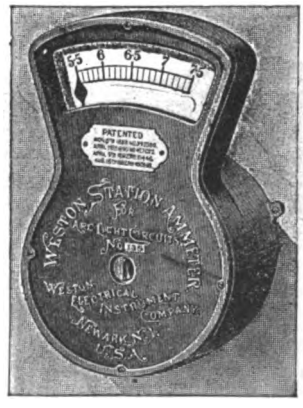
Sold and manufactured by the C. W. Hunt Company, 45 Broadway, New York.

STREET CAR LINES SOLD.

One of the biggest transfers of property ever recorded in Dallas was made recently when twenty-seven miles of street railway and equipment was sold by C. H. Alexander to the Dallas Consolidated Electric Street Railway Company, for $1,000,000. Mr. Alexander recently purchased and consolidated the property, which he sold, for about $300,000. The heaviest stockholders of the new company are Massachusetts capitalists, residents of Boston and Worcester. The new organization took charge at once.—Tradesman.

New York, N. Y.—The Knickerbocker Telephone & Telegraph Co. has been incorporated by Samuel B. Lawrence, Francis P. Lowery, John B. Summerfield, Henry M. Haviland and others; to operate lines in this city and New Jersey, with extensions to Ogdensburgh and Buffalo. Capital stock, $7,500,000.

Philadelphia, Pa. — The Germantown & Fairmount Park Street Railway Co. has been incorporated by Charles E. Morgan, W. Rotch Wister, William G. Warden, Josiah M. Bacon, Samuel T. Bodine, Richard Ashhurst, Joseph Bushnell and William Wharton, Jr. Capital stock, $80,000.



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ABSOLUTELY "DEAD BEAT."

The scale is so proportioned that a change of 1-10 of one ampere can be seen from a considerable distance. Three different ranges:

No. 1—5.8 6.8 7.8 amperes in 1-10 ampere div.

No. 2—8.6 9.6 10.6 amperes in 1-10 ampere div.

No. 3—9.5 10.5 11.5 amperes in 1-10 ampere div.

Mention Electrical Age when writing for Catalogues.

WESTON ELECTRICAL INSTRUMENT CO.

114-120 William St., Newark, N. J., U. S. A.

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Keeps Vacuum Adjusted Automatically. Can not run too high in Vacuum for Operation. Life practically unlimited.

Roentgen-Ray Exciting Apparatus: Thomson Inductoriums, Thomson Roentgen-Ray Transformer Sets, Fluoroscopes, etc. Catalogue No. 9050.

Miniature Lamps: Candelabra, Decorative, Battery and Series. Catalogue No. 9044.

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WATER WHEELS

TURBINE WHEELS, for Heads of 3 to 220 feet.
CASCADE WHEELS, for Heads of 50 to 2000 feet.
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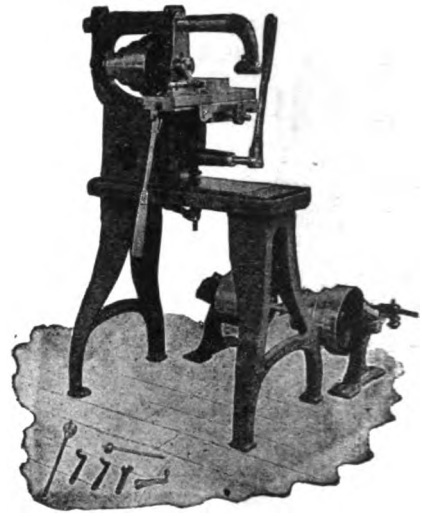

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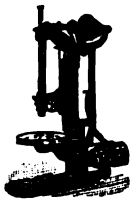

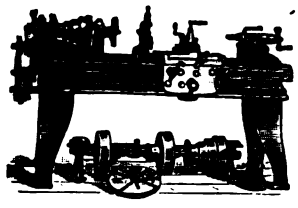

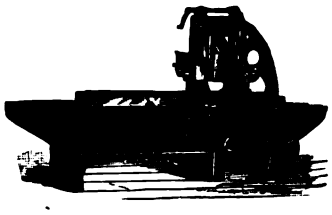

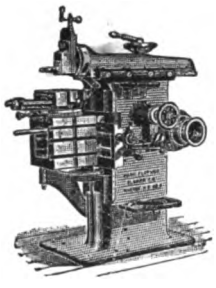

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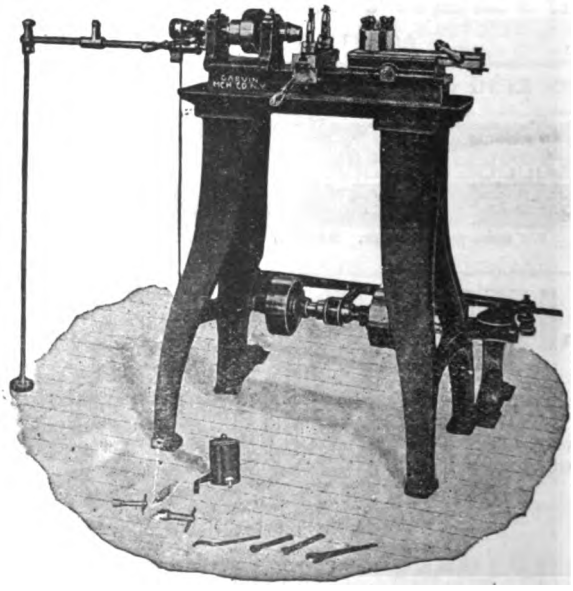

No. 60 SCREW MACHINE (WIRE FEED).

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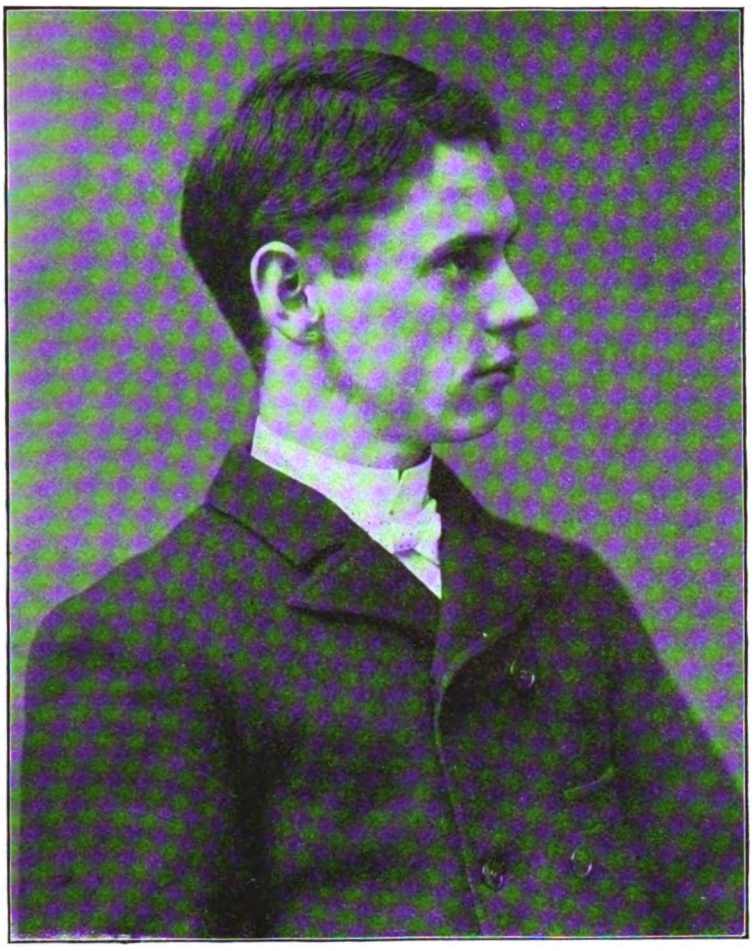
The Electrical Age.

VOL. XXI—No. 11 NEW YORK, MARCH 12, 1898 WHOLE No. 565



DAYLIGHT FROM VACUUM TUBES.

The subject of vacuum tube lighting has received a great deal of care and attention from Mr. John H. J. Haines, born April 27th, 1863, in Lansingburgh, N. Y., and raised in the capital of this state under circumstances that allowed him to give full swing to his inventive genius. One of the fairy dreams of modern science is the manufacture of daylight. Scientific men in England, Germany, France, Russia, Italy and even far away Japan, have endeavored to produce cold light which would not be the result of elaborate and expensive processes, but light produced with a reasonable commercial efficiency. Each day of our lives thousands and thousands of horse power are being wasted in the production of light. We may occupy civilized homes, supplied with every convenience that the mind of man can invent, but we must sadly realize that the savage with his flaming torch can well compare his source of illumination with the light diffused through the rooms of some great Fifth avenue mansion, so little removed is the efficiency of one from the other.

Although thousands of years have passed since mankind discovered and appreciated the value of artificial light, it is only within the last decade and even less that he has sought to imitate nature and produce the cold and uniform glow of daylight. It has often been found by quiet observers of the march of progress that a great discovery is frequently anticipated by scientific men, as shown by their discussions and references in the past. But as far as the practical crystallization of any idea is concerned the great majority fail to leave any impression behind them.

The problem of producing light without waste is one of gigantic proportions, because of the great innovation that its successful solution would institute. To merely produce a phosphorescent glow is not sufficient for the ordinary public; their requirements call for a practical and perfected system which can be readily installed and which will save them many of the dollars and cents they struggle so hard to obtain. Therefore the problem is no longer scientific, but purely commercial, and the honors rest with those that make it in this respect a successful achievement.

To give the reader an idea of the tremendous waste of energy occurring in each system of illumination, it may be

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said that the oil lamp wastes ninety-nine per cent. of its fuel in producing heat; the gas jet, ninety-eight and one-half; the incandescent lamp ninety-seven; the arc lamp, ninety to ninety-five, and the vacuum tube, theoretically, but five or ten per cent. In other words, if the electricity consumed by an incandescent lamp was sent through vacuum tubes, thirty times as much light would be produced, amounting in total to about five hundred candle-power. If the energy consumed in an electric light plant is considered from the coal to the glowing filament, it will be found that for every ton of coal consumed but twenty pounds are directly utilized as light. Prof. Lodge has remarked that as light producers we are like an organist, who in sounding certain high notes is compelled

The inventor, Mr. Haines, Testing his Outfit with Sixteen Tubes. (Photograph taken by Artificial Daylight.)

Mr. Haines and his Colleague Reading by Artificial Daylight. (Photograph taken by Artificial Daylight.)

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to sweep through every note on the keyboard. It may be generally stated in considering light produced from the combustion of gas and light from electrical machinery, that about ninety-five per cent. of all the fuel consumed is absolutely wasted in producing non-luminous vibrations of the ether.

Waves of light are both visible and invisible. In all ether disturbances V = 30,000,000,000 centimetres per second; that is, a speed of 186,000 miles. Dr. Lodge calculates the ether waves of a micro-farad condenser to be 1,200 miles in length at 160 alternations per second, discharging through a coil of one Henry self-induction. A gallon Leyden jar of .003 micro-farad capacity discharged through about seventy-five feet of stout wire emits waves four hundred yards long, at a frequency of 1,000,000 per second. If a sphere two feet in diameter, which has received an electro-static charge, be in any way disturbed, ether waves a yard long will be emitted at the rate of 300,000,000 per second.

Lastly, electric charges on atomic bodies would lash the ether with oscillations of thousands of billions per second, thereby emitting the unseen light of combustion, the ultra-violet rays. It is therefore seen from the above that a short and infinitely rapid ether wave will affect the retina, producing the sensation of light. If an infinitesimal conductor, containing a charge, an atom, for instance, were discharged, oscillations of a tremendous frequency would result. Electro-magnetic waves of the length of light waves would bring to the eye the crowning sensation of visible light.

In a vacuum tube, each particle of gas collides with its neighbor or may possibly undergo the changes above described, but in either case the result obtained is that of a white, uniform glow, pleasant beyond description to an onlooker.

Mr. Haines began experimenting in 1890. His first experiments were crude and unsatisfactory. He realized that a high frequency discharge through the tubes in his possession would be the only means of satisfactorily solving this problem. He followed the work of Crookes, J. J. Thomson, and Hertz, for the purpose of keeping in touch with their experiments.

The apparatus he has devised, and with which he produced vacuum tube lighting of pure whiteness, is unique in every respect. His tubes run perfectly cold and will stand a ten-hour test. With the watt-meter recording two hundred watts in the line he kept sixteen tubes five feet long and two and a half inches in diameter brilliantly illuminated. The photographs contained in this article were taken in a room, having no reflecting screens, with a forty-second exposure, at a distance of from six to eight feet from the source of illumination. One of the important features of Mr. Haine's apparatus is a discharge occurring between two pairs of brass spheres which he calls a double spark gap.

This device is adjustable automatically and is devised for the purpose of keeping the two gaps in resonance. The outfit is self contained, of simple construction, and cheap to produce. Mr. Haines states that his apparatus will be ready for the market in about sixty days, as it has passed the experimental stage and is ready for practical application. A large company is being formed for the development of this invention with a capitalization of $10,000,000.

Picture Taken by Vacuum Tubes at 12.30 A. M.

Mr. Haines is at present interesting himself in telephony without wires. He has produced the only successful open arc lamp, which burns on any frequency, and is manufactured by the Imperial Electric Lamp Company. He has also invented an alternating enclosed arc lamp, now manufactured by the Haines Electric Company. The apparatus Mr. Haines makes use of in producing artificial daylight is attached to the ordinary commercial street circuit with a frequency of 7,200 per minute. The light from his tubes is steady and one can read and write with perfect ease in their steady luminescence.

He has performed the experiment of connecting a chain of nine people, connected by vacuum tubes to the main terminals of his device, and has succeeded in brilliantly lighting the tubes. The radical departures made by Mr. Haines will lead to a rapid revolution in lighting methods and probably become one of the great established systems of vacuum tube lighting in Europe and the United States.

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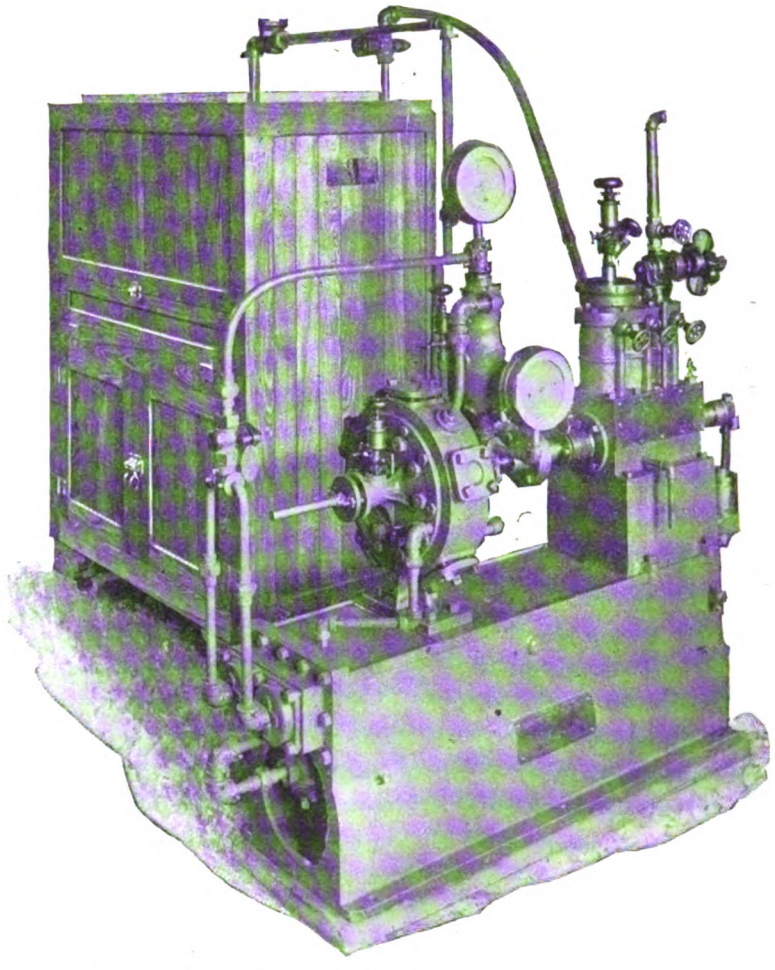
MECHANICAL REFRIGERATION BY ELECTRICAL POWER.

The process of producing artificial cold or, more properly speaking, absorbing heat, though known to a few for ages, is a comparatively new discovery to the many and may really be considered such, inasmuch as the mechanical devices now used in connection with this art have been so greatly improved within a decade that artificial refrigeration is now becoming a necessity on account of its increasing low cost of production as well as the low first cost of apparatus as compared with that of ten or fifteen years ago. It was so high that the attention of inventors and manufacturers was concentrated on large plants only, or where the amount of refrigeration or ice required was sufficiently large to warrant the enormous expense of installation and corresponding operating expenses.

considered. In the tropics ice is often sold for from five to twenty cents per lb. and is therefore one of the luxuries in such countries. A small community, by jointly installing a refrigerating and ice-making plant, could obtain their ice at prices little higher than is paid in New York, and so be able to enjoy daily the cooling fluids and food so necessary to the comfort of life in warm weather, and which indeed must be luxuries in the tropics.

The methods of mechanical refrigeration most commonly known are the compression and absorption, though the former is in more general use and is found to be the most economical. Among the agents for producing cold are ether and anhydrous ammonia, the latter being most favored on account of economy. By means of mechanical devices this is expanded, compressed and condensed,



Ice Making and Refrigeration Combined in Refrigerator.

It will readily be understood that where small amounts of ice or refrigeration were required, in places where natural ice could be procured at fairly low cost, no one would consider replacing the latter for mechanical refrigeration at many times the expense. Today, however, this is changed.

Refrigerating and ice-making machinery has kept pace with other mechanical improvements, and many machines can now be found in the market that will produce as low as 500 lbs. of ice per day, or refrigeration equivalent to that amount of ice melting, at a cost for operating expenses little in excess, if any, of the cost of natural ice in northern latitudes where the price of ice is low. When other advantages are considered, convenience, cleanliness, space used by ice saved, and others we have not room to enumerate here, this cost is very much less than that of natural ice.

When the attention of those living in warm or tropical climes is attracted, there are many other points to be

being used over and over again, only a slight loss occurring by leakage, etc.

The chief expense of operating a small plant such as the Hygienic Refrigeration Co., New York City, are now installing in various markets, hotels, apartment houses, etc., is the power required to run it, and of course this is governed by the kind of power used, the rates of same, etc. The above-named company are now installing several machines that are operated by small electric motors, the latter being mounted on same bedplate with their machine and directly connected to shaft. Others are driven by belt from motor. Electrical power is now supplied at such reasonable rates that the expense of operating by it is moderate, and the power is convenient and clean.

The machines of the Hygienic Refrigeration Co. are practically automatic, not requiring skilled labor to care for them. In many other respects they are greatly in advance of old types, being remarkably simple and com-

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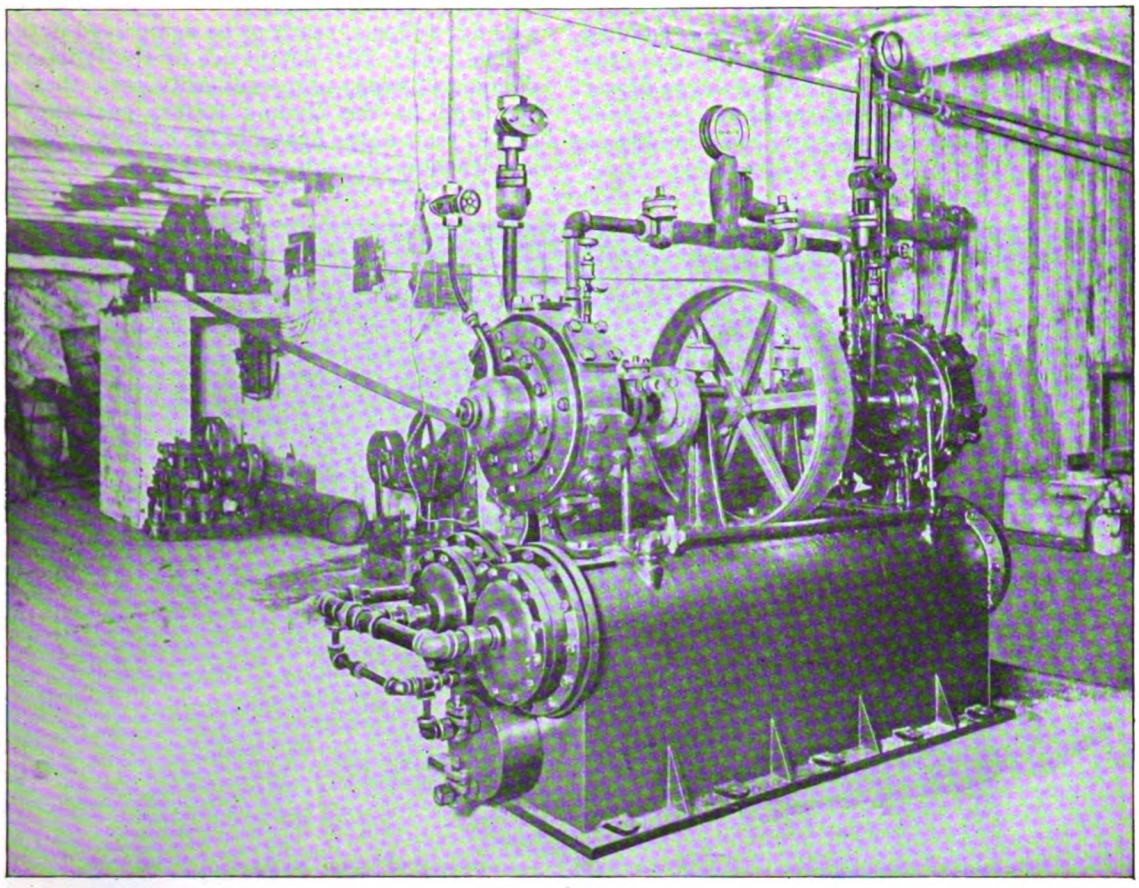
pact in construction, all parts contained in one complete machine. The systems of refrigeration used by this company are the direct-expansion and the brine circulating and storage. By means of the latter their machines need not be operated continuously in order to maintain low temperatures. Several of their plants are now being operated, notably the one shown in illustrations, from 10 to 12 hours per day only. The machine shown in cut



Refrigerating Apparatus Complete—E. C. Brownell & Co., New Bedford. Mass.

Storage Refrigerator—E. C. Brownell & Co., New Bedford, Mass.

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is a double compressor, a great advantage where certain capacities are required. If weather is cool, one compressor will be sufficient for work, and if in need of repairs, the entire plant will not have to be shut down, as one compressor can be overhauled while the other is running.

For use in hotels, markets, dairies, hospitals and other institutions as well as apartment houses and large private dwelling houses, the refrigerating machine is rapidly superseding natural ice for reasons that must be obvious to all.

Each engine exhausts into a Worthington jet condenser, from which the condensed steam and heated injection water is raised by means of the air-pump about 35 feet to the top of a Worthington cooling tower, in the bottom of which it collects, ready to be again used in the condenser.

The boiler feed pumps are of the Worthington duplex compound type, and ordinarily take their supply from the well of the cooling tower, pumping it through a closed feed-water heater in the exhaust line of the pumps, and thence through the economizer to a common feed-

Show Case—E. C. Brownell & Co., New Bedford, Mass.—Cooled by Refrigerating Process.

TESTS ON THE CHICAGO STORAGE BATTERY RAILROAD.*

It is well known that the Englewood and Chicago Electric Steel Railway has operated 20 cars on its lines using the storage battery, and at the beginning of this winter it was decided to test the plant in order to determine the presence and extent of defects which might otherwise exist without attracting attention. The tests were made under ordinary working conditions and represent the conditions of usual practice. They were carried out by Mr. George A. Damon, assisted by Prof. T. P. Gaylord and a corps of students from the Armour Institute. We are indebted to Mr. G. Herbert Condict and to the "Western Electrician" for the data and diagrams.

The boiler plant includes three Heine water-tube boilers rated at 200 boiler horse-power each, fitted with Roney mechanical stokers. The engines are triple expansion, condensing, of the Willans central-valve type, made by the M. C. Bullock Manufacturing Company, of Chicago. The plant at present contains two of these engines, each of which has two lines of tandem cylinders rated at 200 horse-power, at a speed of 380 revolutions per minute.

The engines are directly connected by the "Arnold" method to four six-pole, shunt-wound Walker generators, rated at 190 KW. each when running at 380 revolutions per minute.

* Illustrations loaned through courtesy of "American Engineer."

water heater above the boilers.

The hot flue gases from the boilers pass from the uptakes into a brick smoke flue extending the entire length of the boiler-room. In a brickwork extension of this flue, located between the power-house proper and the stack, is installed a Green economizer, with passages and dampers so arranged that the economizer pipes may be made to intercept the hot flue gases.

Several tests were made and those to which we direct attention were made on November 26, and Fig 1 shows the results of the boiler test on that day, while Fig. 2 gives the data obtained from tests on the engines and generators at the same time.

The tests were made, on one boiler, one engine and two generators, and the three-voltage method of charging the batteries was not used in these cases. The price of the coal at the plant was $1.90 per ton, and from five tests its caloric value was found to be 10,145 B. T. U. per pound. It had 48 per cent. fixed carbon, 33 per cent. volatile matter and combustible, six per cent. of moisture, three per cent. sulphur and ten per cent. of ash. The cards were taken every thirty minutes and showed an average indicated horse-power of 217, and an average electrical horse-power of 172, with an average all-day efficiency of 79.3 per cent. The theoretical evaporative efficiency of 10.5 pounds of water per pound of coal, and the evaporation from and at 212 degrees per pound of dry coal, was 6.6, giving an efficiency of the boiler and firebox of 62.86 per cent., which was obtained while the

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NEW YORK, MARCH 12, 1898.

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TURBO-GENERATORS.

The latest innovation in electric lighting consists of a combination of steam turbine and electric generator, direct connected. The De Laval steam turbine has pushed its way to the front with amazing rapidity and shown its ability to meet many of the demands made upon it. At a test made with a 300-horse-power turbo-generator, operating at the station of the Edison Electric Illuminating Company, of New York, with a steam pressure of 150 pounds to the square inch, with no superheating and a vacuum at outlet of turbine of 25.6 inches, the steam consumption was 25.84 pounds per K. W. hour, at full load.

At the Stockholm exhibition in Machinery Hall a 100 horse-power turbine was shown connected to a direct-current dynamo of 66 K. W.; two 100 horse-power turbines, to which were connected alternators of 66 K. W., and one 50 horse-power turbine connected to a 33 K. W. alternator. The exciter used for the above alternators was driven by a 10 horse-power turbine. It seems from this exhibit that the Swedes place considerable confidence in their turbines for commercial purposes. At the same exhibition, in a separate pavilion styled "Aktiebolaget De Laval's Augturbin," four turbo-generators of 66 K. W. each were installed, and two of 33 K. W. apiece, the plant being fed by a high pressure boiler. The entire exhibition was supplied with light and power from this equipment, the boiler being kept at a steady pressure of 1,700 pounds per square inch. The use of high pressures will certainly cause a change in the construction of steam boilers. Conservative engineers look seriously upon the idea of developing a pressure of almost 2,000 pounds in steam boilers, but they must not forget that their predecessors expressed the same horror at the possibility of running engines at a speed of three or four hundred revolutions per minute. High speeds in steam engines are now accepted without a murmur by the mechanical engineering profession.

It is only a question of time before high pressure boilers and higher speed turbines will be regarded as another cog in the wheels of progress. The simple construction of steam turbines in general without reference to any particular make means, power for power, a cheaper device than the steam engine. The sale of turbines has been growing in Europe in consequence of this advantage as well as those due to compactness and convenience in installation. More than eleven hundred steam turbines have been sold by the Swedish company and the Societe de Laval, in Paris, from 1892 to 1897; the aggregate horse-power disposed of amounting to 32,000. This country is ahead with nearly all classes of machinery but its steam turbines. The time is now ripe for this innovation.

THE LIGHT OF THE TWENTIETH CENTURY.

It seems probable that a new form of illumination will come into use within the next few years. The light obtained from vacuum tubes, containing a highly rarefied gas, has been developed to such a pitch of intensity that the most critical minds would be satisfied with what has been done and admit its immediate usefulness for domestic purposes. The efficient production of light from vacuum tubes depends entirely upon the high frequency of well blended electrical oscillations and experiments have been directed along this line of action, i. e., the use of infinitely rapid vibrations within the tube. As soon as heat is produced, energy is lost, and although electro-magnetic radiations occur in systems employed, which constitute a definite loss, heat within the light-giving chamber is to be shunned as inimical to its success.

A fire-fly emits light which we can only produce by a heat of 2,000 degrees, Fahrenheit, by our modern methods, yet no rise of temperature is perceptible in the light-giving organ of this remarkable creature. Prof. Langley has concluded that Nature produced light in the Cuban fire-fly with about one four-hundredth part of the cost of the energy which is expended in the candle flame. Vacuum-tube lighting has now become a commercial problem—a question of dollars and cents—a prospective system to compete with others. The devices employed by Mr. Haines may be very effective in bringing this peculiar system to the front. The first to market it may be the first to reap the harvest. The public will quickly judge of its merits without bias and their opinions will soon be put to the test.

THE ANACONDA MINING COMPANY is negotiating through the Exploration Company of London, with Mr. William Elmore, of the Elmore Patent Copper Depositing Company, for the use of his new electrolytic refining process, for which he claims a remarkable shortening of the time required by the electrolytic process in making ingots. The old Elsmore process for making electrolytic tubes, sheets and similar work—as the readers of The Engineering and Mining Journal know—was not successful; but it has recently been improved materially by M. Secretan and others, and it is now asserted that excellent sheets and tubes are constantly made. The improvements in the process by which these results are obtained are said to be chiefly in unpatentable details, which overcome the well-known tendency to foliation and prevent the formation of the "pin-holes which rendered the original Elmore tubes unsatisfactory.—Eng. & Mining Journal.

Natchez, Miss.—The Natchez Gas Light Co. will expend about $10,000 in improving and adding new machinery to its electric light plant.

Thomaston, Ga.—J. R. Atwater, Mayor, contemplates the establishment of an electric light plant.

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boiler was 26 per cent. under-loaded. The equivalent evaporation per pound of combustible per pound was 8.22, so that the efficiency of the boiler alone was 78.3 per cent., and the boiler loses by radiation and other causes 21.7 per cent., while the furnace is to be charged with 14.44 per cent. of the lost heat, and the remainder 62.86 per cent. appears in the steam.

The test shows that the engines used 18 pounds of steam per indicated horse-power, but it should be remembered that among the unfavorable conditions, the engines were overloaded and had a vacuum of but 24¼ inches. The indicator cards taken with one engine operating one generator showed a friction load of 32.26 indicated horse-power, which is but about 15 per cent. of the average indicated horse-power. The commercial efficiency of the generator is shown to be 93.1 per cent., which efficiency was obtained when the generator was running 32 per cent. below its rated capacity. The total efficiency from the coal pile to the switchboard was 5.58 per cent. The cost of fuel for a net kilowatt hour on the switchboard of the station tested is shown to be .611 cent. As the result of a two days' run with coal at the price named the cost of fuel per car mile was .996 cent., and the pounds of coal per net kilowatt hour were 6.44.

Fig. 3 gives the result of the readings taken on one of the cars every five minutes during the test while it was performing regular service, and Fig. 4 shows the results of a speed trial for 60 seconds. In this figure, A, B, C, D and E were the readings obtained for the watts used, while the controller was placed at the five points representing the connections as follows: A, the four sets of batteries in parallel; B, batteries in series parallel in sets of two; C, batteries in series with resistance; D, batteries in series without resistance; E, same as D with field of motor shunted. The speed of 15 miles an hour attained at the end of the 60 seconds was after a run of 986 feet, showing at a glance that it is hardly worthy of comparison with the speed of electric and other cars which have been recorded, but the equipment of this car was designed to enable it to attain normally a speed of 15 miles an hour. The tests were made on a 13½-ton car, driven by a 50-horse-power Walker four-pole series motor. The entire current used at any one time passed through the armature, so that the ammeter was inserted in the positive brush leads.

The results of the tests point to the suggestion that the engines should be overhauled, the economizer flue repaired, and the question of securing improvements in the fuel as to quality and cost should be taken up.

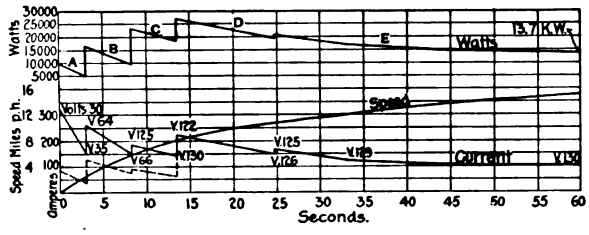

Fig. 4.

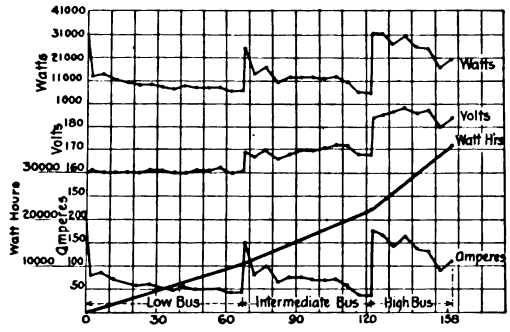

Fig. 3.

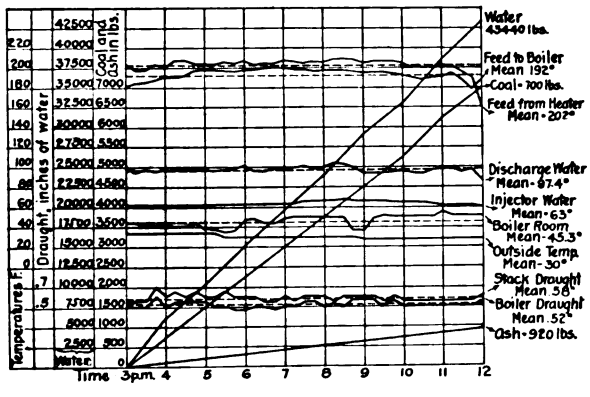

Fig. 1.

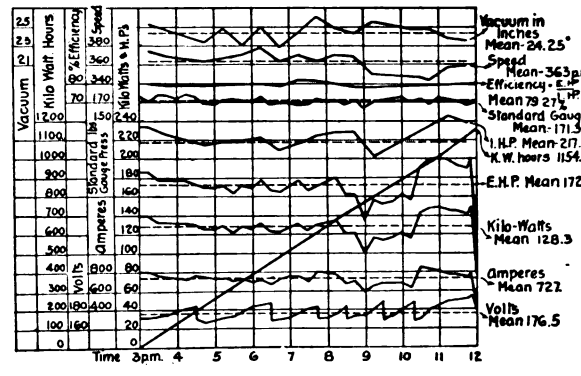

Fig. 2.

LIQUEFIED FLUORINE NON-MAGNETIC.

The much-sought-for alkahest, or universal solvent of the ancient alchemists, is almost realized in fluorine, which was first prepared by Moissan in 1886, says the "Popular Science Monthly." The transparent vessels in which it is contained have to be made of some fluoride, its action on ordinary glass being vigorous and destructive. The difficulty of handling the gas, even in the laboratory, has hence been very great, the fluoride vessels being brittle and clumsy as well as expensive. Professors Dewar and Moissan, being desirous of more fully investigating the properties of the gas, recently conducted a series of ex-

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periments at the Royal Institution in London, in which by means of liquid oxygen they succeeded in liquefying fluorine, and in this comparatively inert state could more fully and carefully examine its properties. The apparatus used for liquefying the gas consisted of a small cylinder of thin glass, into the upper part of which was fused a platinum tube surrounding a smaller tube of the same material. The fluorine enters through the larger tube, passes around the glass envelope, and escapes through the smaller tube. The glass cylinder being cooled down to the temperature of boiling liquid oxygen (—183°), the current of fluorine gas was passed through the bulb without becoming liquid; at this low temperature, however, the fluorine did not attack the glass. On still further lowering the temperature of the liquid oxygen, by exhaustion, a yellow liquid was seen collecting in the glass envelope, while gas no longer escaped from the apparatus. At this moment the escape tube was closed to prevent the entrance of air, and the glass bulb soon became full of a clear yellow liquid possessed of great mobility. Fluorine thus liquefies at about — 185°. The chemical activity of the gas was found greatly reduced when in the liquid state, but even then benzine or oil of turpentine underwent spontaneous decomposition when brought into contact with it. It would thus seem that the powerful affinity of fluorine for hydrogen is the last to disappear. In a subsequent experiment in which liquid air was used and a temperature approximating — 210° obtained, the liquid fluorine showed no signs of solidification. Experiments to determine its density led to the conclusion that it had about the same specific gravity as amber, 1.14. Different samples of the liquid examined with the spectroscope showed no specific absorption bands in the visible spectrum. It was found to be not magnetic.—Ex.

In a recent lecture on the subject of compressed air, these facts were demonstrated: Air when liquefied looks like water, and has a temperature of 385° F. below gas. If an alcohol thermometer be plunged into it the alcohol is immediately frozen. Alcohol being ordinarily frozen at 200. When the bulb and contents are withdrawn, it takes some little time to liquefy the alcohol again, as it has frozen very compactly. The experiment of pouring liquid air into a few ounces of whiskey was undertaken, with the result that the fluids became solidified into a mass resembling a stone or mineral. The smell of the whiskey was however given off in the solid state. When a handkerchief was dipped into the liquefied air it dried very slowly and caused the fabric to have a charred appearance when completely dry again. It would seem foolhardy to thrust the hand into a liquid which can produce such an extreme temperature, but it was proved that no harm would attend so doing, provided it was done quickly enough. The explanation being that a small quantity of the liquid evaporates and forms a thin gaseous film over the surface of the hand and will protect it even though there be a difference of 480° between the hand and the liquid.—Yale Scientific Monthly.

The chainless-wheel craze has now reached the stage where a patent has been granted to a man who wants to belt the main sprocket to a dynamo, run wires back to a motor under the saddle and belt dowu again to the rear wheel from the motor. This adds two belts, two electric machines and much weight in the endeavor to "simplify" the bicycle, but it does away with the chain. It's a good deal like some of the attempts to improve the link motion.—Locomotive Engineering.

JAHL & CO. SUCCEED to the business of G. Humbrock, 39 Cortlandt street, New York. They are selling all kinds of electric light supplies, etc.

ALUMINUM AS A RIVAL OF COPPER AND BRASS FOR ELECTRICAL CONDUCTORS.

BY ALFRED E. HUNT, S. B.
President of the Pittsburgh Reduction Company.

Copper has been used for electrical conductors very largely in the past, due to its comparatively high electrical conductivity, power of withstanding corrosion, ease of soldering and brazing, malleability, tensile strength and ductility. The exceptions in the past have been in telegraph wires of soft wrought iron, and the brass, iron and steel used in the parts of electrical machinery.

Aluminum has already been used successfully for the purpose, and this article is written to call attention to its comparative merits as an electrical conductor.

The following facts regarding the metals, copper and aluminum, in bars, rods, and wire suitable for electrical conductors, need first to be considered:

Copper has a specific gravity of 8.93 (Authority—Association of Copper Manufacturers of the United States 1893); an electrical conductivity, when pure and soft annealed, reckoned at 100 in the Matthiessen scale, but as ordinarily used in electrical conductors of about 98—97.61 (Authority — Prof. W. C. Roberts-Austin); a tensile strength of from 16,500 pounds per square inch in soft annealed pure copper (Authority — Carnegie's Hand Book) to 65,000 pounds per square inch in hard-drawn bars; and a selling price of about fourteen cents per pound in the United States, and an equivalent selling price of 130 marks per 100 kilograms in Germany, for wire, bars, and rods, such as are used for electrical conductors.

Aluminum has a specific gravity of 2.68; an electrical conductivity (Commercially pure metal) of 63.00 (Authorities—Chas. F. Scott, of the Westinghouse Electric Company, and Prof. Jos. W. Richards, of Lehigh University); a tensile strength in pure, soft wire of 26,000 pounds per square inch, and in hard-drawn rods or wire of 40,000 pounds per square inch.

Special Selling Price: The firm of Aron Hirsch & Son, of Halberstadt, Germany, are ready to sell aluminum conductors in the form of rods, bars, plates and wire drawn to 2½ millimeters in diameter, at the special low rate of 280 marks per hundred kilograms, for large quantities of metal, and similarly the Pittsburgh Reduction Company will sell rods, bars, plates, and wire drawn down to No. 12 Brown & Sharp gauge (eight hundredths of an inch diameter) in large special orders for electrical conductors, at the rate of twenty-nine cents per pound at their works in the United States.

These prices are special rates, below the regular prices for aluminum which these concerns have decided to make for electrical conductors alone, in order to favor the introduction of aluminum for this purpose and to overcome the handicap which aluminum has, occasioned by its lower electrical conductivity than copper, in the matter of special low relative prices.

From these facts it is evident that:

1. Any given volume of copper is $\frac{8}{2}\frac{9}{7}\frac{3}{0}$ or 3.332 times heavier than an equal volume of aluminum.

2. The equivalent price of fourteen cents per pound for copper for any length of any equivalent section of aluminum wire or bar, would be 14 cents times the factor 3.332, or 46.65 cents per pound. That is, one thousand feet of wire of, say one-tenth inch diameter, would cost equally as much if bought of copper at 14 cents per pound or aluminum at 46.65 cents per pound. Aluminum, therefore, sold at 29 cents per pound is only about 62 per cent. of the cost of copper at 14 cents per pound section for section.

3. Reckoning the copper conductor to have its maximum of 100 per cent. conductivity, and the aluminum to have a conductivity of 63 per cent. (which the Pittsburgh Reduction Company are ready to guarantee for

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their special pure aluminum metal for electrical conductors), then for an equivalent electrical conductivity a given section of copper that can be placed at 100 should be increased in area in round numbers to 160 to give an equal conductivity.

4. Due to their relative specific gravities, the weight of the given equal length of the aluminum conductor with 160 sectional area will be only forty-eight per cent. of the weight of the copper conductor with sectional area of 100, having the same electrical conductivity.

100 x 8.93 = 893, weight of the copper.
160 x 2.68 = 428.8, weight of the aluminum.
$\frac{428.8}{893}$ = 48 per cent.

5. As to their relative cost for electrical conductors of equal conductivity, aluminum at 29 cents per pound is the most economical conductor as compared with copper at 14 cents per pound.

Taking as an illustration, an aluminum conductor to replace a copper wire of No. 10, B. & S. gauge (about one-tenth of an inch diameter), the aluminum wire of equal, in fact somewhat superior, electrical conductivity would be of No. 8 B. & S. gauge (slightly over one-eighth of an inch diameter).

The weight of a mile of No. 10 copper wire is 162.32 pounds; and its cost at 14 cents per pound would be equal to $22.72.

The weight of a mile of No. 8 aluminum wire would be 79.46 pounds, and at 29 cents per pound, would cost $23.04.

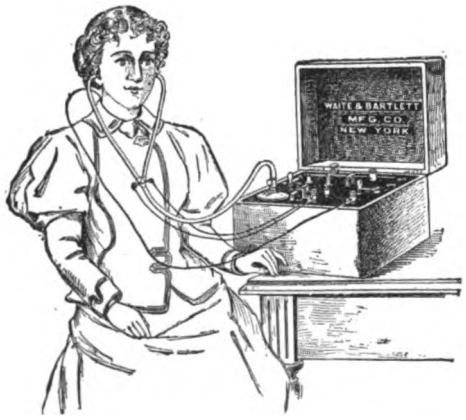
Forty-eight per cent. of the weight of the No. 10 copper wire, which will give equal electrical conductivity in aluminum wire, would only weigh 77.91 pounds; so that more accurately, $22.59 would be the cost of a mile of aluminum wire at 29 cents per pound to replace a mile of No. 10 copper wire at 14 cents per pound, costing $22.72.

6. The Continental requirements in tensile strength for soft copper wire, rods, and bars used as electrical conductors is twenty-two kilograms per square millimeter; the English requirement being similarly fourteen tons per square inch: and our American requirement is about its equivalent of 32,000 pounds per square inch.

(To Be Continued.)

A PHONO-FARADIC CURE FOR DEAFNESS.

In the use of this unique invention two forces are brought into play: an electrical impulse and a mechanical force, both produced from the same cell. These two forces have therapeutic effects on the ear drum when applied of great value, specifically. The faradic effect acts as a tonic to the nerve structure and the purely mechanical vibrations set up in the ear cavity produce a species of mechanical massage. The bombarding breaks down the adhesions on the small bones, while the tonic properties of the other strengthens weak nerves and tissues.



Application of Phono-Faradic Apparatus.

By this combination of a faradic and sound wave effect in one, the treatment of diseases of the ear becomes a matter of much greater ease and simplicity. The above outfit was invented by Dr. Henry C. Houghton; its selling agents are B. & E. Hanfeld, 108 E. 23d street, New York City, well known to dealers in dental outfits and to physicians on account of their long standing relations with medical men. The above instrument, with its wide range of effects, has recommended itself to specialists and to many medical universities.

TEST OF A NASH GAS ENGINE.—Concluded.

Tests of Electric Lamps.

The candle-power of the electric lamps was measured in six positions 60° apart, the position when the loop of the filament was parallel to the screen being 0°.

x = distance in inches from standard Argand burner to screen.

$100 - x$ = distance in inches from lamp to screen.

$$\frac{\text{Candle-Power of Electric Lamp}}{6.4} = \frac{(100 - x)^2}{x^2}$$

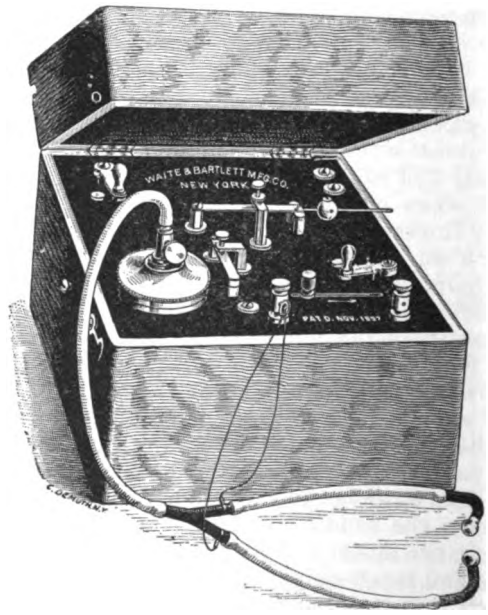
where 6.4 = candle-power of standard Argand burner.

Explanation of Table I.—Comparison of Light.

Table 1 gives the final results, in the tests for the relative amounts of illumination given by electric lights and the gas required to produce those lights. For a heavy load, new electric lamps give 2.21 times as much light as the gas used by the engine would give, medium lamps 1.69 times as much, and old lamps only 1.69 times as much. With a medium load the figures are 2.00 for new lamps, 1.54 for medium, and 1.14 for old lamps.

Six tests were made to determine the calorific power of the gas used, which was shown to yield 701.3 B. T. U. per cubic foot.

The friction of the engine and dynamo was determined by driving them with a motor connected to the engine pulley. The friction, with the cylinder heads off, was found to be 3.83 h.-p., and with the heads on, 4.98 h.-p., showing that 1.15 h.-p. was used in pumping air.



Phono-Faradic Outfit.

The result of a one-hour test for the gas consumption, with no load on the dynamo, showed 95.2 cu. ft. per hour.

A Prony brake test was made with a view to showing the consumption of gas per hour per brake h.-p., which was found to be 17.62 cu. ft., including the gas used to

(Continued of page 152.)

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THE DYNAMO.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

BY looking back upon the past few years, the dynamo appears as a new and untrustworthy device. It was a very interesting piece of mechanism and produced a current capable of doing many wonderful things, but it was not received with confidence. Today what a change has occurred. It is a part of every large hotel equipment, a necessity to public and municipal buildings. The elevators of many tall structures depend upon it and the newest developments tend to force its application for heating our dwellings as well as supplying both light and power.

Principles.—It is encouraging to know that the principles upon which our knowledge of the dynamo is based are of a simple, uncomplex nature, and it may free the mind from doubt to realize that even the early history of the dynamo possesses an interest which unconsciously ripens it for the facts which follow.

The seed which led to one of the greatest industries in the world was planted by a careful gardener, whose discriminating mind selected the richest soil in which to place the precious germ.

But its first growth was not very productive. It required many others of recognized genius, whose ability drew comments from their own government to healthfully develop the first idea. Edison in America, John Hopkinson in England, Siemens in Germany and Pacinotti in Italy added their portion to the accumulating heap of facts. From the very first and most elementary discovery of Faraday sprang a host of useful principles to which we owe the growth and practical utility of the modern dynamo. The elements by reference to which the action of the dynamo can be understood will be contained in the following notes.

Arago in 1824 noticed that a magnetic needle would not swing as often when near a metallic body as it would when isolated from it. Copper exercised the most striking effect, and was spoken of as being able to reduce the oscillations in a short while from 300 to 4.

In 1825 he discovered that a plate of copper, rotated under a suspended magnet, caused the magnet to deflect in the direction of motion. Two other experimenters, Bubbage and Herschel, repeated Arago's experiment and drew up a table showing the relative effects of this action on different metals:

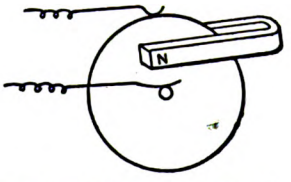
Copper,	100.
Zinc,	95.
Tin,	46.
Lead,	25.
Antimony,	9.
Bismuth,	2.

Faraday with characteristic genius explained these effects in a manner acceptable even to the most sceptical minds. The rotation of the magnet above the copper disk generates currents in it which react upon the magnet. The way in which they react is to destroy the swing of the needle, in the first case, or force the magnet or needle out of its customary position in the second. The law, framed by Lenz, which covers all such cases in which a magnetized body and a metallic mass move in each other's neighborhood is as follows:

Lenz's Law.—In all cases of electromagnetic induction, the induced currents have such a direction that their reaction tends to stop the motion which produces them.

It is but necessary to appreciate this fundamental fact, and the phenomenon of electromagnetic induction in all its phases appears as but a simple and reactionary effect. In fact, to some minds the presence of a current by the movement of the magnet was expected. A force cannot be applied at one point without producing some equally disturbing effect at another. Matter is simply the material by which a given amount of power is transmitted and, therefore, a swinging magnet radiating lines of magnetic force must create in the conductor they strike some such remarkable effect as we perceive. The idea of Faraday's regarding the disk of Arago took root. Faraday himself, in 1831, discovered the principle of induction; he followed the work of Arago and constructed a small dynamo. It consisted merely of a disk of copper revolving between the poles of a magnet, but it gave a continuous current and was named the Faraday disk dynamo.

Arago's Original Experiment.



Faraday's Disc Experiment.

Today machines are used of the same construction in some electro-metallurgical works. Noting in mind the fact that a magnet moved in front of a conductor has its motion resisted, or the converse, a conductor moved past a magnet has its motion resisted, the reason why such retardance is necessarily due to induced currents becomes pretty evident. A magnet moving through the air cannot be held any more than any other object, unless by the presence of another magnet. Neither have touched, yet they either repel or attract each other.

If currents are induced in a mass of metal or a conductor by a magnet, and the production of such currents means resistance to further motion, it is highly evident that the disturbing influence is magnetic, otherwise the magnet would be unaffected. Also the currents which are reduced, and which affect the moving magnet, must hold it back when it moves away and push it away when it moves back. Any movement whatever is restrained, and

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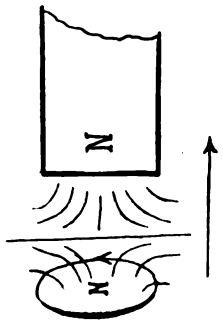
this restraint is investigated from these two standpoints.

(1) Motion of magnet to a coil.
(2) " " " from "

QUESTIONS FOR REVIEW.

(1) What experiment was performed by Arago ?
(2) State Lenz's Law.
(3) How is the Faraday disk dynamo constructed ?
(4) What phenomenon is due to the movement of a



conductor past a magnetic pole ?
(5) How are results of such motion classified.

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ignite the burners, and 17.37 cu. ft., not including the gas used to ignite the burners.

Efficiency of Dynamo.

The tests compared in the following table are a 4-hour test on the electric output and a ¾-hour test on the brake h.-p.

Load.	Corrected Gas per hour.	Watts.	H. P.	Per Cent. Slip.
Electric.....	397.1	13125	17.59	7.01
Brake.....	394.5		22.71	

From curve of watts and gas for loads of 10.1, 8.7, and 13.1 kilowatts, the number of kilowatts corresponding to a gas consumption of 394.5 cubic feet is 12.97.

---

* This ratio is the candle-power of light emitted by the electric light to the candle-power of the gas when burned in a flat flame burner, The ratios are greater than unity, which shows that there is more light generated by the electric system for a given amount of gas than by burning the gas in a flat flame burner.

If a = total power delivered by engine to friction clutch,

If y = efficiency of dynamo including friction,
b = fraction of total power lost in friction clutch,
p = external electric h.-p.,

$$\text{Then } y = \frac{p}{a\,(1 - b)}$$

12.97 kilowatts = 17.39 h.-p. $= p$

$$y = \frac{17.39}{22.71\ (1 - .0701)} = \frac{17.39}{22.71 \times .9299} = .831$$

Efficiency of Engine.

Taking the gas per hour per brake h.-p. = 17.62 cubic feet. and the calorific power of the gas per cubic foot as 701.3 B. T. U.,

$$\text{the efficiency of engine} = \frac{60 \times 33000 \times 100}{17.62 \times 701.3 \times 778} = 2.06\%.$$

Conclusion.

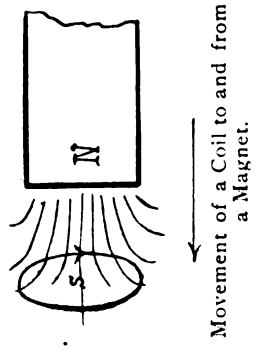
The results of the tests are as follows:—
First.—Best length of air pipe = 3 feet.
Second.—Best position of gas valve, 7½.
Third.—Gas per K. W. per hour (full load) = 30.83 cu. ft.

Fourth.—The amount of light given by electric lamps which have been in use some time is 1.69 times as much light which the gas used to drive the engine would give if burned directly in burners.

Fifth.—Calorific Power of Gas = 701.3 B. T. U.

Sixth.—H. P. lost in friction of engine and dynamo = 3.83 = 13.8 per cent. of total h.-p.

Seventh.—H.-P. lost in pumping air = 1.15 = 4.2 per cent. of total h.-p.



Eighth.—Prony brake h.-p. = 22.71.

Ninth.—Gas per brake h.-p. per hour = 17.62 cubic feet.

Tenth.—Gas per hour to drive engine and dynamo (no load) = 95.2 cubic feet.

Eleventh.—Efficiency of engine = 20.6 per cent.

Twelfth.—Efficiency of dynamo = 83.1 per cent.

The above test of a direct-connected Nash gas engine and Dynamo, referred to in The Stevens Indicator, October, 1897, shows the economy of generating electric lights by this method.

Not alone are electric lights produced at an extremely low figure—less than 31 cubic feet of gas per kilowatt—but much more light is realized when the gas is used in the engine to generate electric lights than if it is used direct at the burner.

This amounts to 2.21 times when new electric lamps are used, and 1.69 times when medium lamps are used. (This includes gas consumed for igniting burners.)

The average price for furnishing 16-candle-power electric lights is usually one cent per hour per light, when supplied from the street service.

This test shows that 16 c.-p. electric lights can be produced by the Nash gas engine at less than one-fourth of a cent per lamp hour when using gas costing $1.25 per thousand feet.

Where gasoline is used, costing 8 cents per gallon, the cost would be one-tenth of a cent per lamp hour. The Nash gas engine is manufactured by the National Meter Company, 118 Chambers street, N. Y.

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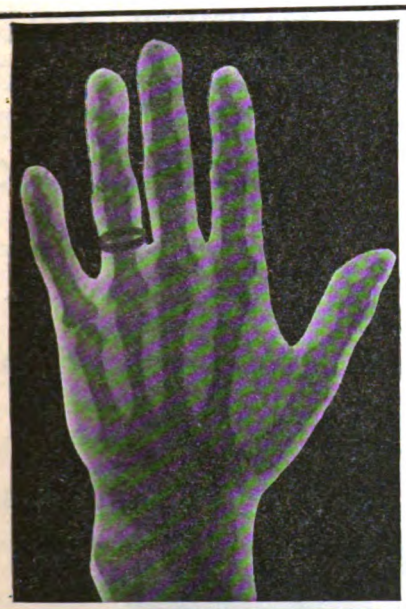

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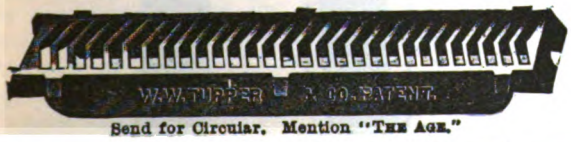

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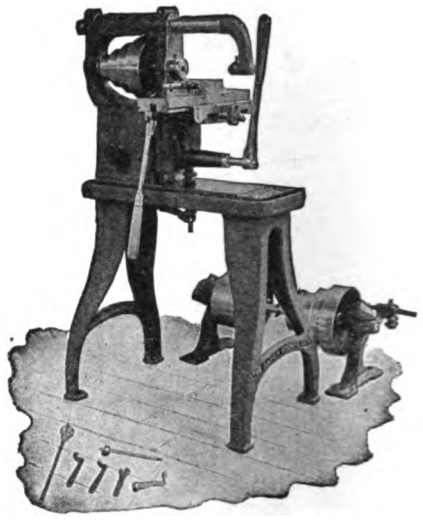

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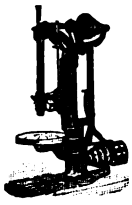

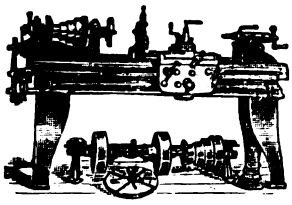

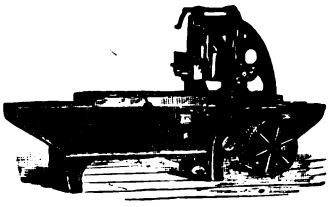

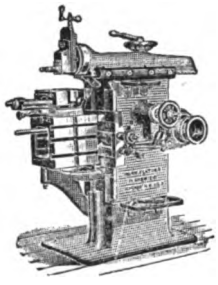

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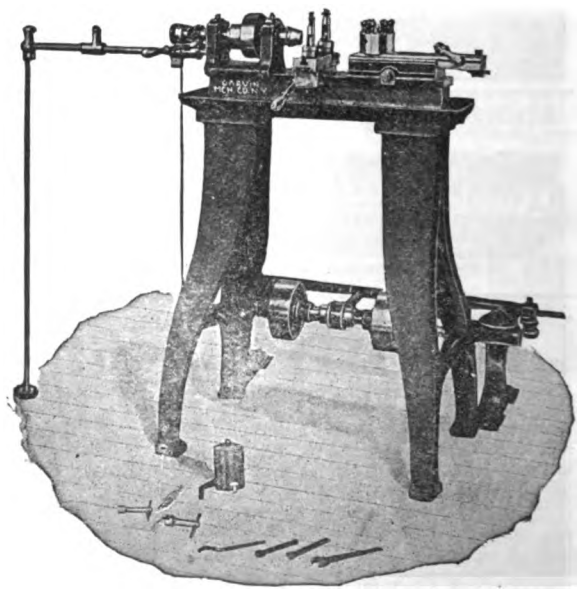

No. 60 SCREW MACHINE (WIRE FEED).

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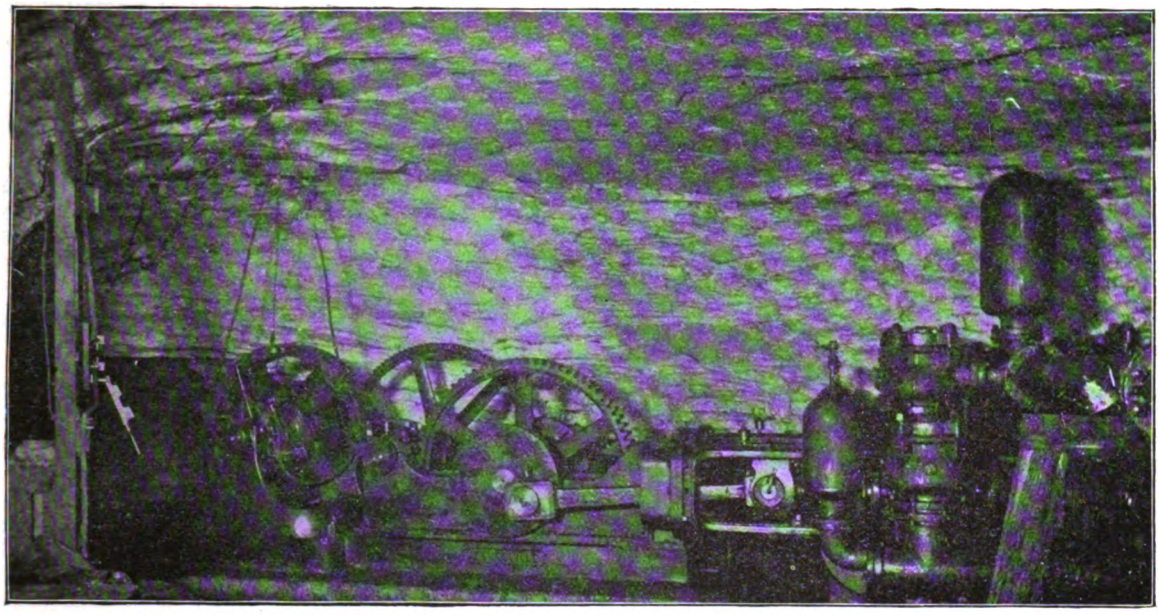
The Electrical Age.

VOL. XXI—NO. 12 NEW YORK, MARCH 19, 1898 WHOLE NO. 566



10-in. x 18-in. Pump and 85 H.-P. Motor.

ELECTRICITY IN THE LEHIGH VALLEY COAL MINES.

In the mines of the Lehigh Valley Coal Company, four miles north of Wilkesbarre, Pa., an interesting electrical installation has been in operation during the past year. The main workings of the mines are under the Susquehanna River Flats eastward from the shaft toward that river from the Wyoming Hills—the Western outcrop of the anthracite coal belt.

As the workings were greatly extended the problem of handling the constantly increasing volume of water became daily more difficult and the haulage of coal by mules more expensive. A steam plant on the flats was impracticable on account of their submersion and, after careful investigation, the Company decided to use electricity for the operation of the mine pump, and an electric cable hoist for the haulage of the coal over an extension of the main gangway.

The power house is placed near the head of the main hoisting shaft and contains the main hoisting engines, the generator and its driving engines. Steam is supplied from a battery of boilers set in another house about 200 feet away. The dynamo is a General Electric slow speed, 150 K. W. direct-current six-pole machine, driven by a Ball automatic tandem compound non-condensing engine. The speed of the engine is 200 R. P. M., that of the generator 400 R. P. M. The generator is compound-wound for 500 volts at no load and 550 volts at full load. An oak switchboard is placed against the wall of the engine room and current passes from the generator to the switchboard through heavily insulated copper cables suspended on porcelain insulators in a conduit under the floor.

The conduit is provided with a removable cover allowing ready access to the cables. The board is provided with two double pole feeder switches for the pump and hoist circuits in addition to the main double pole station switch. The pump circuit is protected by fuses, the hoist circuit by an automatic circuit breaker. From the two feeder switches the pump and hoist circuits are carried to the pole line. The positive and negative sides of each circuit are connected to suitable lightning arresters to protect the instruments and generators from the destructive effects of lightning.

The pole line runs from the station to a point almost above the centre of operations and the wires are run through a bore hole especially drilled for that purpose. The poles are 30 feet long and each carries one four pin cross arm with iron braces, wooden pins and glass insulators.

The positive feeders for the pump and hoist circuits consist of two separate 0000 B. & S. wires, and two 0000 B. & S. provide a common return. At about 5,000 feet from the power-house two bore holes, each 350 feet deep, are driven from the surface of the flats. One is provided with a six-inch iron pipe as a casing for the wires, the other with a 12-inch casing for the pump discharge. The six-inch pipe rises about 18 feet above the surface of the ground, the opening is thus protected against any rise of water during freshets. A small cable house is supported on this pipe, into which the line wires pass and make connection with the cable in the bore hole. The two positive feeders are connected to two separate cables; the two common return wires to one large negative cable; each cable is heavily insulated with rubber and jute braid, and then leaded and armored with iron wire protected from corrosive and electrolytic action by tarred jute. The cables are supported from the top of the stand pipe.

The method of suspension of the cables is unique. Six cast iron plates, 1¼-inch thick and 18 inches square, are drilled with three 2-inch holes close together near the centre of the plate. The six plates are placed one above the other on top of the stand-pipe and the cables pass through the holes in all of the plates. The six plates are divided into three sets, each two in a set forming a clamp tightened by several small bolts. As one cable passes through the bottom clamping set the iron-armored wires are spread out and tightly clamped between the two plates.

Another passes through the hole in the first set and is clamped between the plates of the second set, the third armored cable being held between the third set. Each cable is, therefore, supported by its own armor and a separate clamp. Three additional lightning arresters protect the cable and line wires in the cable tower.

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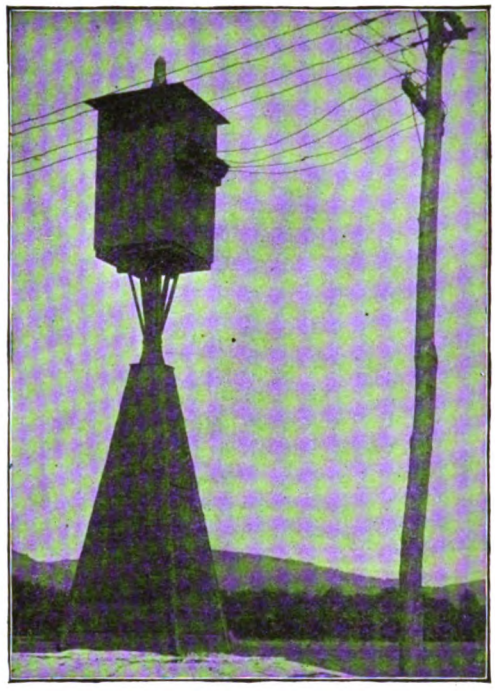
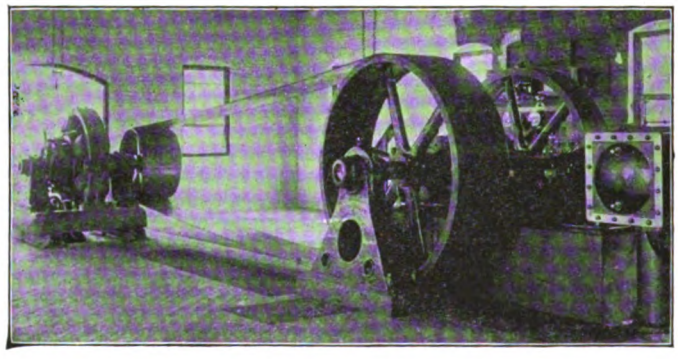
At the bottom of the hole the cables are connected by single pole-switches to the circuits operating the hoist and pump 600 feet distant. These underground wires are double rubber-covered and are supported on glass insulators fastened to props along the ribs. A wooden switchboard carrying fuse boxes, main switch and starting rheostat for the pump is erected in the pump chamber.

The motor for this pump is mounted on a cast iron bed plate and is geared by a double reduction gearing to the crank shaft operating the plungers. The motor is a General Electric shunt-wound machine, with a capacity of 85 H. P. continuously at a speed of 700 revolutions per minute. The pump is a duplex, double-acting pot-valve pump, manufactured by the Jeansville Iron Works with outside packed and connecting plungers, 10 inches in diameter x 18 in stroke. The pump capacity at 25 revolutions is 600 gallons per minute, under a head of 360 feet. As with all pumps operated with shunt-wound motors the speed of the gearing is approximately constant—a great advantage where the pump receives little attention and where the pump capacity is limited. Should the pump happen to run on air there would be no racing, as in the case of air and steam pumps, and the amount of energy consumed is only that required to overcome the mechanical friction of the rotating parts. The suction pipe drains from a large pump near the pump chamber, and the water passes up through the 12-inch bore hole to the surface, where a check-valve prevents the water returning during any freshets when the pump is not in operation. A small 4-inch x 6-inch triplex plunger pump geared to a 5 h.-p. multipolar slow-speed motor, pumps water up the small slope to the large electric pump.

The hoist is placed at the head of a small slope extending east from the parting at the foot of the main slope. The gangway in which the pump is placed is from 20 to 25 feet high and rather narrow. The hoist is placed on a platform built over the gangway and the operator stands on an auxiliary platform directly behind the hoist, where he is not troubled by the vibration of the hoist when running. The motor is of the General Electric Railway type, completely closed to protect the windings from dust and moisture. It is series-wound for 500 volts and is capable of developing 110 h.-p. for the intermittent work it is called upon to perform. The motor and drum are mounted on the same bed plate, and are connected by double reduction gears.



Point of Suspension of Feeders.



Power House.

The drum is of the friction-cone clutch type, manufactured by the Lidgerwood Manufacturing Company, and is provided with two band brakes lined with wood. The clutch and brakes are operated by three levers and quadrants, while the motor is operated by a rheostatic controller to the left of the levers. The controller is provided with a magnetic blow-out. The hoist drum is 48 inches in diameter and 36 inches face, and holds about 1,400 feet of one-inch wire rope.

Under full load the rope strain on the hoist, at an average speed of 500 feet per minute, is rated at 5,000 pounds. The hoist is operated under the single rope

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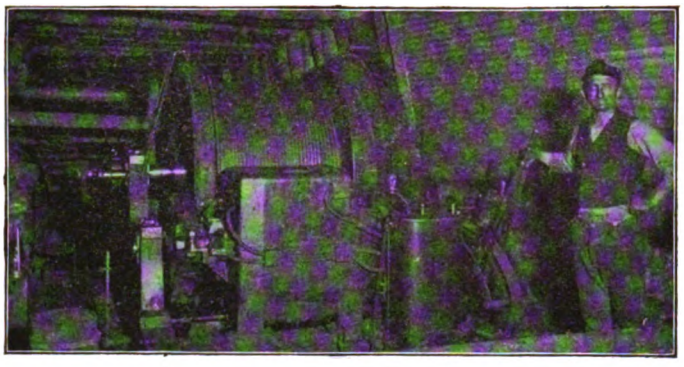
system, the empty trips are lowered by gravity and overhaul the rope, while the loaded trips are hauled up out of levels situated at intervals along the slope. The lowest level is about 1,200 feet from the hoist. The slope pitches on an average about 5°, with a maximum of 8° at the approach to the knuckle, above which the empty and loaded trips pass on a parting directly under the hoist.

The usual load up the slope is four loaded cars per trip at an average speed of 500 feet per minute. Each car weighs about three and a half tons, loaded, and in case of necessity the hoist is capable of hauling six cars per trip.

The installation of this plant was effected by the General Electric Company, and since it was started has operated continuously with satisfactory results.



110 H.-P. Hoist at Head of Slope.

ALUMINUM AS A RIVAL OF COPPER AND BRASS FOR ELECTRICAL CONDUCTORS.

BY ALFRED E. HUNT, S. B.
President of the Pittsburgh Reduction Company.

(Continued from page 150.)

Aluminum wire, rods, and bars will be furnished of 63 per cent. electrical conductivity, which will have an equal tensile strength per unit of area with the copper, and therefore with the electrical conductivity equivalent of forty-eight per cent. of the weight of the copper and sectional area of 160 against the area of the copper section 100, the tensile strength of the aluminum conductors will be as 100 for the copper is to 160 for the aluminum. This would mean if a square inch of copper conductor was used of, say, 32,000 pounds per square inch tensile strength, the equal conductivity area of 1.6 inches of aluminum would have a tensile strength of 51,200 pounds.

It has been already determined that with aerial lines, the snow and ice load is practically as heavy on lengths of small wire as upon larger sections, so that no objection upon this score can probably be found to the use of the larger sections of aluminum wire.

Both on account of having only 48 per cent. of the weight and on account of having about 60 per cent. more strength, the aluminum conductor could be used in much longer spans between supports, and the number of expensive poles and insulators can be materially diminished. Properly drawn aluminum wire is as tough and will stand bending as severely without breaking as soft copper wire. The toughness of aluminum wire is, however, greatly modified by the care and skill used in manufacture. If it is drawn too severely through the dies or is not well annealed at the proper intervals in the drawing operation, it is finished much more brittle than when properly manipulated.

Hard-drawn copper wire, especially that in the smaller sections drawn through diamond dies, is furnished with a tensile strength of 65,000 pounds per square inch. What the maximum tensile strength of the best pure hard-drawn aluminum will reach under similar favorable conditions for developing the maximum tensile results, has not yet been determined, but from experiments already made it can quite surely be predicted that at least 50,000 pounds per square inch can be obtained, and perhaps even higher strength still.

Aluminum hardened with a few per cent. of alloying ingredients can be furnished in wire with a tensile strength far in excess of what can be obtained in pure aluminum. Experiments are now being made by The Pittsburg Reduction Co. to determine just what alloy will furnish the maximum tensile strength, together with maximum electrical conductivity. From results already obtained, it can surely be predicted that an alloy of aluminum can be furnished which drawn into wire will have a tensile strength of at least 65,000 pounds per square inch and electrical conductivity of more than 50 in the Matthiessen scale. This material to rival hard-drawn copper wire and the silicon-bronze materials which are now in use, where maximum tensile strength together with good electrical conductivity are required.

The power of withstanding corrosion is greatly in favor of aluminum as an electrical conductor over copper. Copper does not change in dry air, but in moist air it becomes covered with a green layer of basic carbonate of copper, which itself has a corroding action and does not coat and protect the underlying copper from further corrosion. Ammonia in contact with copper absorbs oxygen and the copper dissolved in consequence of the formation of a soluble cupric-oxide and ammonia. This action is especially a source of trouble where copper wire is used in connecting rail joints in the tracks of electrical railroads where the ground is often subjected to ammoniacal solution.

Aluminum similarly is not acted upon in dry air and the corrosion in moist air is of the oxide of aluminum, alumina, a harmless salt which forms an impenetrable coating on the metal and protects it from further corrosion to a considerable extent. Ammonia solutions act on aluminum only upon the surface, attacking it and leaving behind a more resisting surface coating of a brown color containing silicon, which resists corrosion from dilute mineral acids and dilute solutions of organic acids as well as moist and dry air. Subject to sulphur gases such as locomotive flue gases, aluminum withstands corrosion better than copper.

If kept free from galvanic action with any other metals electro-negative to itself, aluminum is far less easily corroded than copper.

The difficulty of soldering or brazing aluminum is the chief drawback to its use as an electrical conductor. Aluminum can be soldered strongly, but it is a more difficult and slow operation at best as compared with copper, and there is much more rapid weakening of the soldered joint due to galvanic action between aluminum and the metals of the solder than with the less electropositive metal, copper.

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In many places the aluminum can be first coated with copper and the soldering or brazing operation made on the copper surfaces thus formed.

Several forms of joints have been successfully used to avoid the necessity of soldering; the best forms being to use thin aluminum sheets to wrap the joints and to twist or otherwise bind with the aluminum bars or wires to be joined. These wrapped and twisted joints with aluminum sheets can be left smooth on the outside when desired, can be made much stronger than the body of the conductors, and are really a more serviceable job than soldered or brazed work in many cases with copper. One very practical way of making joints of aluminum wire is to roll the thin aluminum sheet of about six inches width into two cylinders from opposite edges of the sheet. These double cylinders are very cheaply made on mandrels in a lathe. The ends of the wires to be joined are inserted in these cylinders from opposite ends and both the wire and sheet twisted with pliers until a firm joint is secured, much stronger than the body of the wire. The joint can readily be made impervious to the air and moisture.

The C. McIntire Company, of Newark, N. J., have a patented joint which is made very much along the lines of this joint. Information regarding their patented form of joint can be obtained by correspondence with them as above. Also the American Electric Fuse Co., Chicago, Ill., make a very satisfactory joint.

Another disadvantage which handicaps aluminum in special uses for electrical conductors will be, where the material has to be insulated, that the cost of insulation will be approximately one-third greater for the larger section required in aluminum over the cost for the smaller section of copper required for the given conductors; and where aluminum is to economically compete for insulated conductors, the price of the aluminum will have to be further reduced to meet this contingency.

Aluminum is soon to be placed in an extensive line of conductors where this added extra cost of insulation will be determined by actual fabrication; The Pittsburgh Reduction Co. in this particular case agreeing to pay the added costs, in order that actual experience may be gained as to their relative amounts.

There are certain places where aluminum will be at a disadvantage over the smaller section of equal conductivity of copper, in ducts or conduits where space is a considerable item. In such cases, the use of aluminum would necessarily be prevented.

An ample field for the employment of aluminum for some time to come, however, seems open at the present time for bare transmission lines, especially for high-potential long-distance work and for long-distance telephone lines and for rapid transmission telegraph lines.

Aluminum next to gold is the most malleable of all the metals and is much more malleable than copper.

Aluminum in ductility stands next to copper and is easily drawn into all sections that are furnished in copper for electrical conductors.

Aluminum can be furnished fully as uniform in its composition as copper.

The metallurgy of copper is comparatively complicated, owing to the difficulty of converting its ores into the oxide free from impurities. In most of the copper ores used, sulphur, lead, and iron are contained as well as small quantities of other elements, as arsenic and antimony. All of these elements in metallic copper very materially lower its electrical conductivity. The native pure copper of the Lake Superior region enjoys the preference, due to its uniformity and freedom from impurities, for many purposes, but for electrical conductors the electrolytic copper is most used.

Aluminum can now be furnished rivalling for electric conductors at least 99.50 per cent. pure—it is granted not as yet in purity of composition—the best electrolytic copper used for the purpose of electric conductors. When as pure metal is obtainable it will undoubtedly more nearly rival copper in electrical conductors, section for section.

Aluminum has been already in successful operation as an electrical conductor for some time. The first use in a large way was with the conductors for the electric current at the Niagara Falls Works of the Pittsburg Reduction Co., where it has been used since the year 1895; the currents were of several thousand horse-power each and of very large volume and comparatively low voltage. Both in conducting power, freedom from heating effects, power of withstanding corrosion, ease of making, wear, and efficiency of joints, the aluminum conductors have given better results than copper used for the same purpose.

In the Chicago Stock Yards, a mile of aluminum wire of No. 11 gauge has now been in use for some time, upon a telephone line that has been badly corroded out in copper wire, due to its being frequently subjected to sulphur gases from passing locomotives. The aluminum line is giving good satisfaction and is withstanding corrosion much better than did the original copper wire subjected to the same influence.

If the theory be true that the passage of high voltage alternating currents of great frequency is largely upon or near the surface of the conductors only or mainly, then the larger section of the proposed aluminum conductors will make them especially adaptable for such currents.

On telephone lines, it has already been determined that as good sound transmission is obtained with aluminum of equal section as with copper, in ordinary lengths of less than ten miles of wire. No comparative results, however, have as yet been determined on long distance telephone transmission; but the evidence would seem to point that a much less section than 160 of aluminum to 100 of copper will give equally good results.

Aluminum is now being used to replace brass very considerably in the arts, as it is sold in the open market at rates which make it ten per cent. cheaper, section for section, than brass.

For electrical purposes, the metal can be advantageously used to replace brass in a good many ways. Commercially pure aluminum as furnished today contains less iron than does commercial brass, and is therefore more non-magnetic than brass.

The electrical conductivity of aluminum is far superior, section for section, to brass. Almost every electrical apparatus of present construction in which an iron core—usually a laminated iron core—is used, in motors, generators, or transforming machinery, has spaces for ventilation, and the spacing is made by the means of drawn bars, flat rods or angles or tee-shape pieces. Brass has been almost invariably used for this purpose in the past—probably on account of its non-magnetic properties as compared with iron or steel. Drawn aluminum sections can be furnished at a price which is ten per cent. cheaper than brass, section for section; and on account of the lightness of aluminnm, it can be advantageously used.

Where a low electrical conductivity is desirable, as in parts that are moved in a magnetic field, to prevent the occurrence of eddy-currents, aluminum can be alloyed with zinc and other metals that will lower its electrical conductivity to the desired points.

A STEEL FRAME BOX-CAR.

In an interesting paper, read at the December (1897) meeting of the Northwest Railway Club, Mr. H. H. Vaughan presented a design for a 40-foot, 60,000-pound box-car, which has some novel features, among the most important of which is the use of the side framing of the upper part of the car for carrying the load, the object of this being to reduce the weight of the car to the lowest terms. The load in Mr. Vaughan's design is provided for entirely by the car sides, and the centre sills are supported and are used for local strength and for the pulling

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and buffing stresses. The car is 8 feet 6 inches wide over the side sills and has a total floor space of 330 square feet, which will accommodate a load of 60,000 pounds. Mr. Vaughan describes the design in the following words:

"The general design is shown by Fig. 1, and it will be seen that the truss is of the ordinary 'N' type, with posts in compression. The transoms are 30 feet centres, and the floor is carried by four beams at the panel points, which are spaced about 6 feet apart. Each of these floor beams would carry a load of 9,300 pounds if the load were uniformly distributed, but I consider that the possibility of heavy local loading must be taken into account, and for this I have allowed a double load of 18,600 pounds on one floor beam, but under these circumstances have taken the load on the adjacent floor beams at 4,700 pounds, making as before a total of 28,000 pounds for three beams. I believe that such an assumption will be found to meet all cases that will be encountered in practice, as no machinery or metal will be loaded that would give rise to greater local weights.

The diagram Fig. 2 shows the stresses on the framing, the left-hand side being for a uniformly distributed load and the right-hand side for a load concentrated as above described, but symmetrical with respect to the centre. The weight of the frame sheathing, roof, etc., is included. The allowable stresses in the various members are taken as follows:

On framing, 12,500 pounds per square inch for tension, 8,000 pounds per square inch for compression.

"On rivets, 7,500 pounds for shearing, 15,000 pounds per square inch for bearing.

"By reference to Fig. 1 it will be seen that the posts and braces are made of 3-inch channel, 5 pounds per foot, and the maximum stress will be 10,000 pounds for tension and 6,800 for compression. The transom post is a 5-inch channel, 6.5 pounds per foot, and the stress on it is 7,600 pounds per square inch. The side plate is a 4-inch channel 5.5 pounds per foot; the maximum strain for this occurs between the door posts, and for a uniform load is 8,300 pounds per square inch, but as this is a continuous section, an excess is perfectly allowable, and it is prevented from buckling sideways by the roof, fascia boards and door track.

"The buffing and pulling strains in this car are taken by two 10-inch channels, 16.5 pounds per foot, which run the entire length of the car. The combined area of these is 9.8 square inches, or as great as that in the shank of the coupler, and in my opinion should be strong enough to resist any shock that will not entirely wreck the car. The collapsing strength as a column is about equal that of the four centre sills in a 60,000-pound car, and would appear ample by that comparison."

The paper also treats of the resistance to bulging of the ends and sides of the car, showing the necessity for providing for these stresses especially in steel members acting as struts, because the fiber stresses increase very rapidly under combined compression and bending, and also because steel has less margin between elastic limit and rupture than wood. To guard against these stresses the three-inch channels shown at posts and braces are placed with their webs at right angles to the sides or the ends of the car, which gives a strength of about four times that of wooden posts. Another feature of the design is the arrangement of the posts so that the loads come upon the outside of the posts at the top ends and are transmitted to the car at the bottom on the inside of the posts, whereby the eccentric loading is almost entirely neutralized. To guard against stresses caused by poling or pushing the car from one corner, the designer uses diagonal braces from the corners of the car to the centres of the body bolsters. He considered it desirable to attach the draft rigging directly to the sills by riveting, which would probably save repairs.

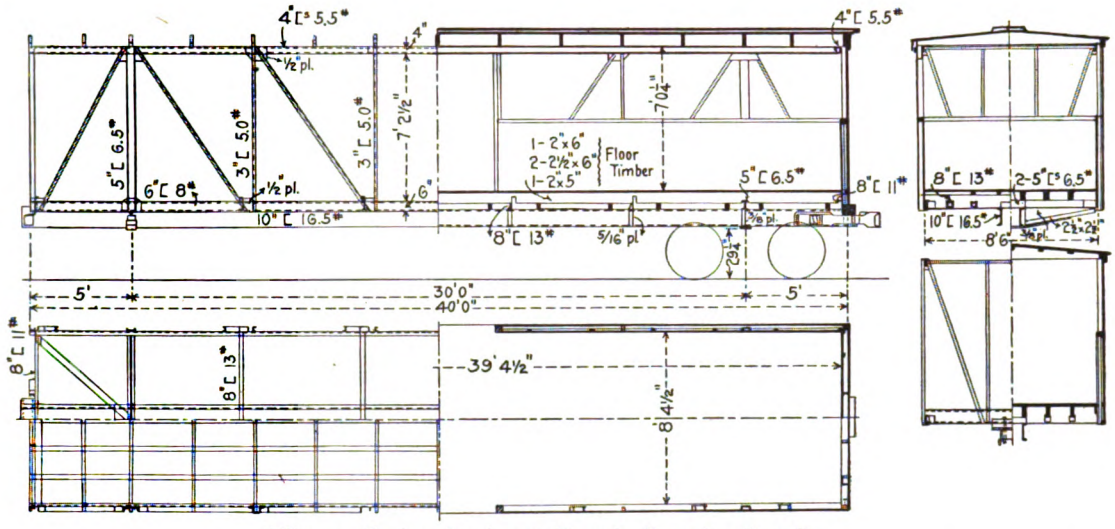

*Fig. 1—Design for 60,000 Pounds Capacity Box Car.

The weight of a car body built on this plan was put at 17,500 pounds, which included all attachments and fittings above the trucks. The details of the weight are as follows:

	Pounds
Steel frame with centreplates and attached castings	6,440
Floor beams, belt rails and railing strips	1,350
Roof and running board lumber	2,150
Sheeting side and end door lumber	2,470
Floor	1,270
Coupler and draft rigging, deadwood, etc	1,220
Brakes	1,980
Side and end door iron work	220
Hand holds, corner plates, etc	250
Bolts, nuts, etc	160
Total	17,510

The total weight of a wooden car body of this size and capacity was 20,000 pounds, or 2,500 pounds more than that of the steel car, the difference being in the first two items in the list. Allowing for variations which might be required in his design after placing it in service, the author considered one ton per car to be the amount saved by his design over a wooden car. Then by figuring on the car mileage he places the cost of hauling one ton of extra weight in a car for a year at $27; this amount, and probably also a saving in the cost of repairs, should be credited to the use of such a car.

In conclusion, Mr. Vaughan says: "The trussed frame car in some form or other offers the lightest car for a given capacity, and while it is less sturdy than those with metal underframe alone, it appears to me the most advantageous form to use."

*Cuts loaned through courtesy of Amer. Engr.

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A GENUINE TOURNAMENT.

S already announced the New York Electrical Society, during the month of May, will give, under its auspices, an electrical exhibition in Madison Square Garden, New York. In connection therewith, an auxiliary and educational committee has been formed to take general charge of exhibition matters other than commercial, and it has been decided that one or more evenings duriug the exhibition shall be set apart for a telegraph tournament, and we take great pleasure in advising the "crack" senders and receivers of America to tune up their keys and sounders and get on their best gait, for there will certainly be a "hot time" in Madison Square Gar len some time during the month mentioned.

It goes without saying that this will be the greatest telegraph tournament ever held in the world. The committee has secured the services of Mr. Fred Catlin, who is the most competent gentleman to successfully conduct an affair of this magnitude. Mr. Catlin is justly termed "the father of telegraph tournaments," for, with one exception, he has managed every telegraphic contest which has been held in New York since 1866, when Mr. Pat Burns, of Boston, won the gold key, including the Bunnell key contest, in the Western Union Building in 1884, which was won by Mr W. L. Waugh ; the Victor key contest in the United Press rooms in 1885, won by Mr. J. W. Roloson, and the great national fast-sending tournament at Hardman Hall in 1890.

These affairs were not conceived or carried out by Mr. Catlin with a view to pecuniary gain, but through his interest in the matter of bringing the art of telegraphic manipulation up to its highest point. We have heard him say he would prefer hearing the music of a Roloson's, Gibson's, Kihm's, or Frank Catlin's transmission to listening to the grandest of operas, and in this respect he is not unlike many whom we have met.

Mr. James D. Reid, the "the father of the telegraph" and well known to every operator the world over, has consented to act as chairman of the board of judges. Mr. Reid's appearance on such an occasion as this will be hailed with positive delight by the fraternity at large, and no doubt his presence will encourage operators from all sections of the country to visit New York to capture some of the numerous prizes.

Mr. J. B. Taltavall, a member of the auxiliary and educational committee, will also assist in looking after the interests of the telegraph boys.

In conversation with Mr. Fred Catlin a few days ago, he remarked that he also was determined that the telegraph tournament should be a success in every particular and that it shall surpass any previous affair of its kind. The management will spare no efforts to make this feature of the exhibition a most attractive and successful one. The prizes will be liberal and the contests numerous, and there will be ample opportunity for the young talent which has come into the field since the last tournament of five years ago to show of what stuff it is composed. "It is my opinion," said Mr. Catlin, "that the records will be smashed by more than one.

"The exact dates of the contests have not yet been determined. If it is found that one afternoon and evening are not sufficient time for running off the various classes, more time will be allotted.

"Handsome medals or badges will be awarded to the winners, to which will be added liberal cash prizes.

"The prevailing opinion, in which I concur, is that the same matter should be used in every telegraphic contest for the purpose of comparison. It is just as necessary and important in this work as it is that the mile-race track should measure exactly 5,280 feet.

"At the tournament of 1893 the top records were :

	Minutes.	Words.	
Kihm,	5	248	perfect.
Catlin,	5	248	"
Gibson,	5	246	2 errors.
Mecredy,	5	249	14 "
White,	5	248	10 "

"The matter used in the contest of '93 was entirely different from that used in '90, so exact comparisons of work done cannot be made. The transmission of Mr. Pollock in the tournament of 1890, while it was the most remarkable ever listened to in a public contest in the matter of speed, would not have been acceptable under the conditions of the contest of 1893, owing to the frequency of imperfect characters. It is possible for a first-class operator to read easily perfect transmissions up to a speed of about sixty words per minute—a speed not likely to ever be reached by hand transmission. The value of transmission is lost when it is not rendered clear and accurate, and judges will so render their decision."

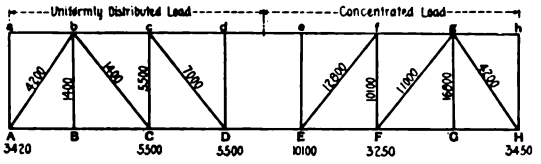

Fig. 2—Stress Diagram.

Mr. Catlin will as soon as possible issue a circular for the information of operators desiring to participate in the contests. This circular will contain records of past tournaments, conditions to govern the coming affair, classifications, date of closing of entries, the matter to be used in transmission, and other things which may be suggested as being of interest to the fraternity.

Of course one of the features of the tournament will be a typewriter receiving contest, which it is expected will be participated in by the friends of every known typewriter on the market.

The most liberal prizes will be awarded to the victors, and we can assure those who wish to participate in this tournament, whether residents of New York, Chicago or San Francisco, that they will be well taken care of and repaid for their trouble if they will visit New York and take part in this greatest of all telegraph contests.

RAILWAY EARNINGS IN SWEDEN.—Under date of February 12, 1898, Consul Winslow writes from Stockholm: I have the honor to send a synopsis of the annual report of the state railway system in this kingdom. The year 1897 brought a golden harvest, and a very material increase in business is shown by the following figures: The number of passengers carried was 8,379,096, of which 37,358 were first class, 1,122,872 were second class, and 7,228,866 were third class. In addition, there were carried 117,020 soldiers and prisoners. The number of animals carried amounted to 563,494 head, of which 21,422 were horses, 22,040 dogs, and 320,152 cattle and swine. The receipts were: Passengers, $3,125,000; transportation of mail, $200; transportation of live stock, $195,000 ; total freight receipts, $,500,000; sum total with other items for 1897, $9,600,000; sum total for year 1896, $8,250,000.

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TWELVE THOUSAND VOLTS IN THE LONGEST UNDERGROUND LINE IN THE WORLD.

The transmission of power over long distances has been successfully performed in many notable cases. The secret of economical power transmission is to be found in the use of a high pressure. The development of alternating current systems has been greatly stimulated through inventions relating to polyphase motors; in fact, the adoption of two and three-phase systems for commercial use only became successful since motors have been perfected to run on these circuits.

There are certain questions arising in the consideration of power transmission systems which have been so well answered by modern electrical engineers as to cause wonderful progress in the transmission of power at pressures that could have not been even insulated a few years ago. The point to be considered in the use of thousands of volts in a transmission line is one met with in every text-book dealing with the subject of transmission of power. It is as follows: "With double the E.M.F., or half the current, we require only half the cross-section of wire. We can therefore deliver current twice the distance with the same percentage of loss in the wire. A ten-thousand foot line, carrying five hundred volts, loses 25.9 per cent.; a 20,000 foot line, carrying 1,000 volts, loses exactly the same amount of energy."

It is obvious that power transmission has become eminently successful through a full comprehension and application of this principle. High-tension transmission lines are not only placed upon poles with suitable insulators attached, but laid underground in conduits. In Germany it is the practice to paint poles carrying high tension wires with a skull and cross-bones. But even this does not prevent the little village boys from throwing stones at the insulators and taking extreme delight in fracturing them.

This is but a mild case of the difficulties met with by proprietors or managers of high-tension transmission plants. Of late, paper-insulated cables have come into use for high-tension service, and to one we call particular attention. It is a cable more than nine miles long, which has easily withstood a pressure of 18,000 volts for more than eight hours. This is the longest underground three-phase cable in the world. It carries a steady pressure of 12,000 volts and transmits the power running all of the city of St. Paul's trolley cars, which represents 2,000 horse-power at the very least. An exceedingly high pressure test has been made of the St. Paul cable, during which 25,000 volts were sent through it. An extract from a letter received by the National Conduit and Cable Company from the Twin City Rapid Transit Company states that "this cable, over nine miles long, carried 18,000 volts alternating current for over eight hours. After this test the high potential switches were broken on 12,000 volts, when the cable was transmitting 700 horse-power." The present pressures used will gradually be raised in the near future. It is very likely, in view of the economy due to these high voltages, 20,000 and 30,000 volts will be used on transmission lines. There is one conclusion to be drawn from the above statement and that relates to the remarkably high insulating power of the materials used in covering transmission lines, particularly the high grade of paper-insulated cables. The demands made upon the manufacturers of cables and conduits have increased year by year until at present we view an illustration of the survival of the fittest. The pressure used for power transmission has grown to such enormous figures that only those manufacturers able to deal with this problem in a highly scientific as well as commercial manner have remained in the field.

The others through incompetency have passed away, and as the tests become severer and the requirements greater, manufacturers of conduit and cable will find their only salvation in a policy as outlined above.

So far, however, remarkable results have been obtained through the earnestness with which cable manufacturers have continued their experiments. The profession owes a great deal to those whose confidence in high tension electrical transmission have instituted such changes.

The power plant at Niagara will soon be but one of many, and who knows but that a perfected system of high-tension transmission will not soon override the railroads by transmitting thousands of horse-power from the coal mines direct to large cities, burning the fuel where it is found, and saving thereby the millions of dollars that its carriage calls for.

ELECTRIC RAILWAYS AND LIGHTS IN FRANCE.—Consul Jackson of Cognac, under date of February 25, 1898, reports that the city of Niort proposes to have an electric railway and lights for its streets. Communications should be addressed to Monsieur la Maire de la Ville de Niort, Deux-Sèvres, France. There is also, says the consul, a movement on foot to connect La Rochelle with the new port, La Pallice, by an electric line 2½ miles long. Communications should be addressed to Monsieur P. W. Morch, Chamber de Commerce, La Rochelle, France.

Tests were recently made by a celebrated French mechanical engineer to ascertain the work expended in the propulsion of a bicycle. It was found that at ten miles per hour the work per semi-revolution was 18.58 foot-pounds, and at twenty miles an hour it was 63.62 foot-pounds. From this it would seem that the work of propelling a wheel at twenty miles an hour is more than three times as great as the effort expended to keep it running at ten miles an hour.—Locomotive Engineering.

Muscatine, Iowa.—The Mississippi Valley Telephone Co. will shortly establish a new telephone line.

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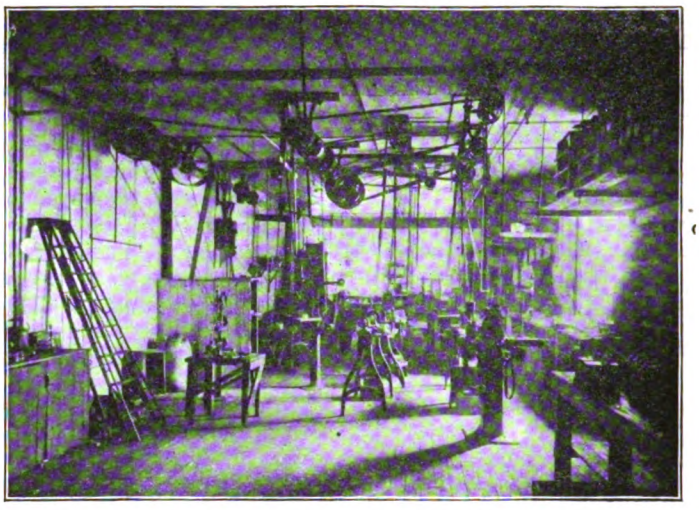
THE TELEPHONE WORKSHOPS OF DE VEAU & COMPANY.

The quarters occupied by De Veau & Company, of 27 Rose street, New York, possess every facility for the rapid construction of telephonic apparatus. The latest types of machinery are in use and the most modern methods employed in the construction of De Veau outfits. All materials and goods are handled at the Rose street end of the factory. Adjacent to the office, which is separated from the work-room, is a spacious shop in which all the machinery employed is to be found. The lathes, screw machines, drills and tables are of the kind most suited to the rapid construction of the telephones, magnetos, transmitters, etc. Everything is systematically arranged, so that no delay is experienced in assembling the apparatus.

De Veau & Company have earned a worthy name through the high grade of their telephone equipments. The best of materials are used and the greatest care taken in the fitting and perfection of each individual part. Their telephone switches are decided improvements over others already on the market. They make a better contact and possess a greater range of action, and in other respects override competition. The transmitter consists of a carbon disk, permanently attached to the diaphragm. At the back of the transmitter is another diaphragm stamped with concentric corrugations. Coal grain carbon is held between the two disks by a piece of wool cloth, thus holding the granulated particles between diaphragm and diaphragm. A spring gives the utmost flexibility, holds the carbon particles in place, but also allowing vibrations to be clearly transmitted. A covering of oiled silk between the diaphragm and mouthpiece keeps the transmitter free from moisture. This exceedingly delicate and practicale instrument operates with a single cell in circuit.



*New Telephone Factory of De Veau & Co.

Besides the above transmitter many other interesting pieces of telephonic apparatus are manufactured by De Veau & Company, including a watch-case receiver of excellent design. De Veau outfits may be found on board of U. S. war vessels Brooklyn, Iowa and others not quite finished. They make a specialty of divers' telephones and will supply any form of telephone used in marine ork.

De Veau & Company possess an excellent reputation as manufacturers, their goods being known among the world's producers of telephones. They will be glad to extend every courtesy to friends visiting them at their new quarters.

*New Telephone Factory of De Veau & Co.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—The twenty-first convention of this association will be held in Chicago, Ill., June 7, 8, 9 next. The headquarters of the association will be in the Auditorium Hotel, and hotel rates will be from $3.50 to $5 on the American plan or $2 to $4 on the European. The meetings will be held in the banquet hall of the hotel, which have been kindly offered for the use of association.

*Cuts loaned through courtesy of Elec. Review.

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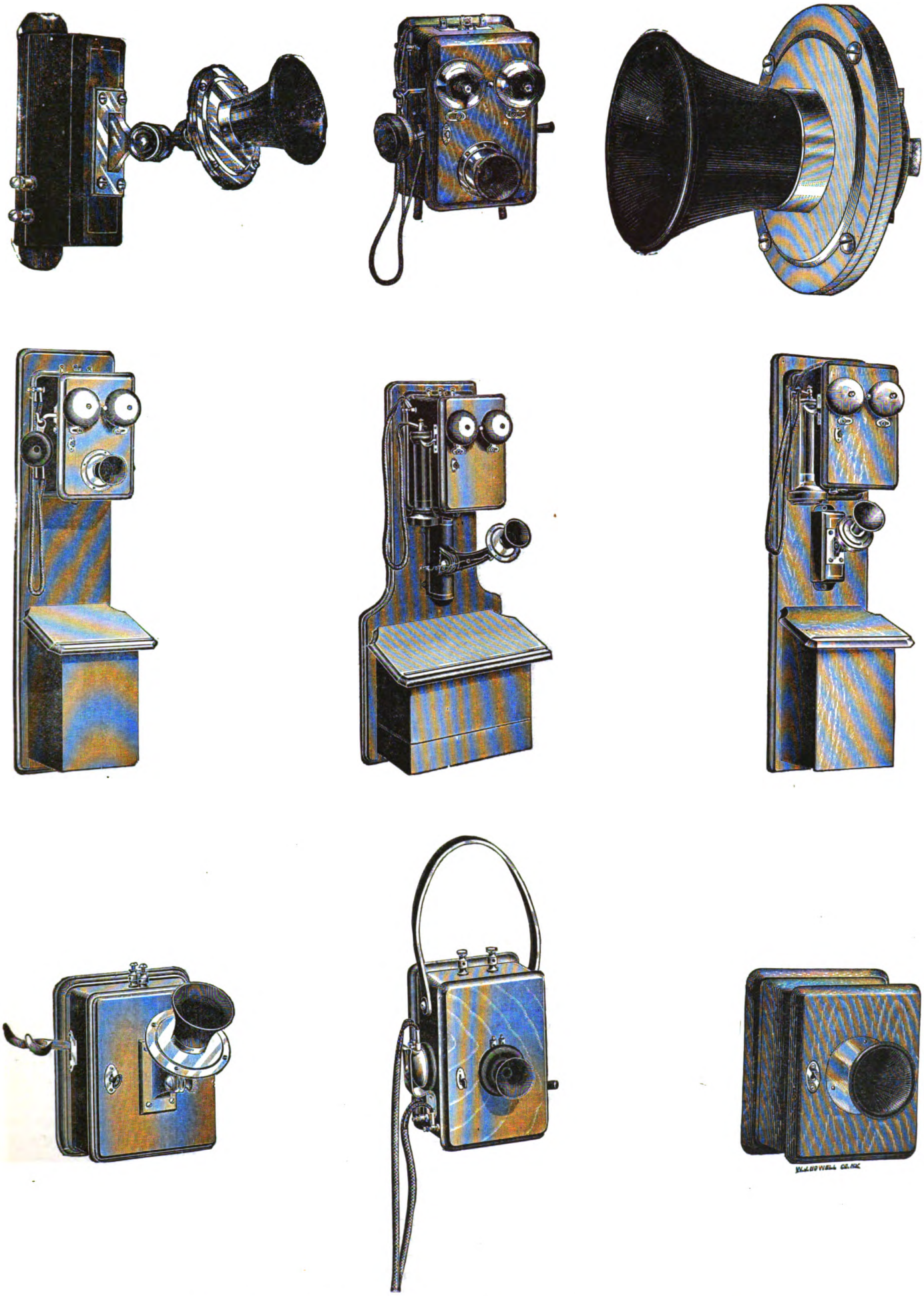

DE VEAU & CO.'S TRANSMITTERS AND TELEPHONE OUTFITS.

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INCANDESCENT LIGHT AND EDISON SYSTEM.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

The history of electric lighting is not very old. Its different branches have developed to such an extent that some of the heaviest investments in this country are made in electric light plants. The electric light systems of the United States may be divided up into two general departments:

Incandescent Lighting.
Arc " "

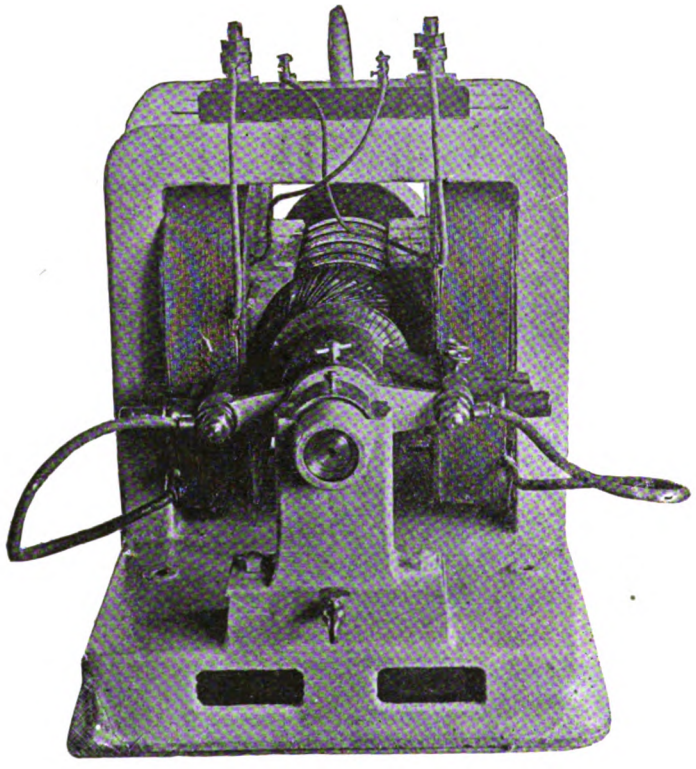
Under the heading of the first we are prepared to consider the development and present condition of incandescent light systems.

Basis of Lighting System.—Any wiring system which will allow a uniform pressure to prevail throughout is valuable in two respects:

(a) Lamps are saved.
(b) Light is constant.

Under the conditions mentioned the long life of a lamp is assured. There is no greater cause of breakage in lamps than the rising or fluctuating pressure in the lamps. Again, from a purely commercial standpoint the constancy of the light is so important that, unless some means is taken to keep it constant, customers cannot be retained, and the damage caused by this double difficulty becomes irreparable.

Function of the Dynamo.—To keep the pressure constant in the line the dynamo itself must preserve a uniformity of pressure, or at least within very slight variations. The line depends upon the dynamo, but by means of an ingenious arrangement the dynamo can be also made to depend upon the line. By the two affecting each other we have a system sensitive to outside changes. Compound winding enables us to retain the pressure about constant, or at least to raise or lower it when so desired. This at once brings us to a consideration of the cause of such changes.



Iron Clad Dynamos.

Kinds of Lighting.—The lighting of incandescent lamps is effected either by continuous or alternating current. An incandescent lamp only calls for a certain pressure and current; when these are supplied the lamps at once become normally bright and the problem of incandescent lighting, as far as the light is concerned, is complete. There are, however, certain stringent reasons for observing such limits as are imposed by circumstances, and which prevent the attainment of more than a limited light without extraordinary expense. That to which reference is made is the line circuits which carry the current, and which by their arrangement practically gives the system of lighting its name. The success of incandescent lighting depends entirely upon the size, length and support of the line as well as the nature of the dynamo and its additional attachments. The most common system of incandescent lighting known is the Edison. There are in this system certain features which have made it the superior of all others. The reason for this is due to the fact that all the wiring represents a network of squares, arranged in such a manner that one point is at the same pressure practically as any other. The secret, therefore, of successful incandescent lighting is the preservation of a uniform voltage at all points.

Regulation.—The dynamo would not require any extra device if the load upon it were constant, but the continual changes affect the dynamo as follows: When the dynamo is supplying 110 volts and a load of lamps are thrown on, the pressure may fall to 105 volts, due to the

drop in line,
armature reaction,
drop in armature.

Conversely, if the dynamo is laboring under full load and the lamps to a large extent are removed, the pressure will rise from the point it is at and perhaps cause serious injury to the remaining lamps. A regulating device is therefore necessary when circumstances cause such rapid changes as these. The device used is in itself simple enough.

Compound Coil.—A rise or fall in volts is due to the conditions enumerated; a loss of volts in the armature,

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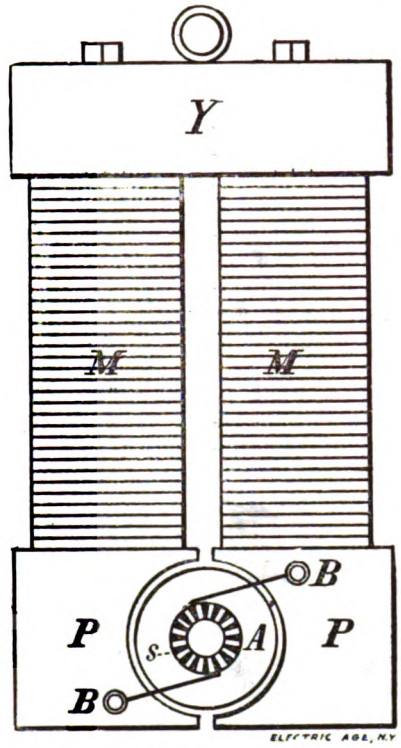
a loss in the line and armature reaction. These three factors pull down the voltage considerably, and their combined effect is very noticeable with each increase in the number of lights.

To compensate for this loss the dynamo is made sensitive to the changes of load in a very simple manner. A coil is wound around the magnets of the dynamo of large enough wire to carry the current of the line; when the current in the line increases the ampere turns due to this winding increase also, and the dynamo has its pressure increased because the ampere turns have strengthened the field.



Y—Yokes. M—Magnets. P—Poles. B—Brushes. A—Armature.

If these changes are automatic the dynamo will adjust its potential to the number of lamps, and always be high enough to keep them at normal candle power. The ease with which this arrangement works is surprising; it is in popular use in every isolated as well as central station plant.

The success of incandescent lighting depends upon a wiring system that causes as little loss as possible with the greatest possible variations in current.

The Edison network is the nearest approach to perfection of anything we have. It consists in the main of three parallel webs of wire; between each two adjacent webs there is 110 volts pressure, and between the two most apart, the first and third, 220 volts. The economy of saving one wire and yet having two lighting circuits that are independent, yet in close combination, is obvious. The two outer circuits, between which there is always 220 volts, are greatly used for motors. When the same number of lamps exist on each side of the middle web of wire the system is said to be balanced. The web-like formation is due to the fact that the wire is distributed through streets, which give it the shape of a netting with square meshes, each mesh including one block.

QUESTIONS FOR REVIEW.

(1) Name the two great electric light systems.
(2) What kinds of incandescent lighting are in vogue?
(3) What must be preserved in an Edison system of electric lighting?
(4) State the benefits of a good wiring system.
(5) What purpose does the dynamo serve?
(6) Why must the dynamo regulate?
(7) What is a compound-wound dynamo?

AMATEUR MODEL MAKING COMPETITION

AT THE ELECTRICAL AND KINDRED INDUSTRIES EXHIBITION.

A committee consisting of Prof. Loeb, Dr. A. Doremus, Dr. W. E. Geyer and Mr. T. C. Martin has drawn up rules and regulations for an amateur model making competition in connection with the electrical exhibition. Printed forms can be had from the Management, 15 Cortlandt street. The classes are given below, each class having prizes not to exceed $50.00 and bronze medals, the exhibits to be judged by a committee of five well-known men. It is believed that the contest will awaken general interest and elicit some beautiful and interesting apparatus. There are a great many young people and students in and around New York who find pleasure in handiwork of this character. The classes are as follows, and the exhibits must be entered a week before the exhibition begins.

Class A.—Working model or actual machine of a dynamo-electric or electro-dynamo type; made by one or more boys under twenty-one, so far as designing lathework, assembling and finishing is concerned.

Class B.—Instrument of precision, made by amateur or student; including galvanometers, resistance bridges, etc., etc.

Class C.—Practical application of electricity to communication, the assembling to have been the work of a single exhibitor.

Class D.—Ingenious application of electrical appliances to domestics, etc., uses by an amateur under eighteen; none of the apparatus to be necessarily of home manufacture.

Class E.—Design or working drawing of an electrical appliance or installation, made within the past twelve-month by a student of a recognized chartered institution, and bearing the instructor's certificate.

Class F.—Design or instrument made by a teacher, below the grade of college professor, for illustrating some electrical law.

Nanaimo, B. C.—The Nanaimo Light, Heat and Power Company are seeking to extend their powers.

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GREAT VERMONT POWER PLANT.

The Winooski river, which flows across northern Vermont and played so prominent a part in the history of the state during the French and Indian wars, is now destined to hold a no less important place in its industrial development, says the Electrical Review.

Between Essex Junction and Burlington, about two miles from the latter place, the river has cut an immense gorge through the rocks nearly 100 feet in depth. Just at the head of this gorge the stream divides, leaving a high rocky island in the centre. At this point the Vermont Electric Company has installed one of the most substantially built and finely equipped electrical plants in New England.

The dam, which is 204 feet long, 31 feet high, and 60 feet thick at the bottom (with an apron 12 feet wide extending across the top), is built of wood and stone, 700,000 feet of hemlock timber being used for the crib, which is filled with stone. A large reservoir is thus formed, furnishing abundance of water even in the driest seasons of the year, and giving a maximum head of 40 feet.

There are at present three turbine water wheels developing an aggregate of 1,600 horse-power, and openings in the dam for five more wheels of 600 horse-power each, which will be added as required.

The power-house is 115 by 60 feet, and is built of stone and iron, set on a solid masonry foundation extending across the stream, and is a model of arrangement; so smoothly does every part work that very little vibration is perceptible even when the entire plant is in operation.

Extending the entire length of the upper story of the power-house is a 7-inch steel shaft 210 feet long, to which the turbines are belted by 52-inch belts, and from which are belted two 225-kilowatt Westinghouse three-phase generators (2,500-volt primary, 250-volt secondary); two 2,000-light Thomson-Houston alternators (2,000-volt primary, 104-volt secondary), and five 60-light Brush arc dynamos. Each dynamo is provided with a voltmeter and ammeter and an automatic circuit governor.

The switchboards are of skeleton pattern, made of iron and marble, provided with down-pull knife switches, and so arranged as to connect the dynamos in series or to any circuit desired. The several circuits, after leaving the dynamos pass out of the power station through a tall cupola to the poles.

To provide for any emergency that might occur by the breaking down of the water-power plant, a steam plant has been installed consisting of three 125-horse-power and one 150-horse-power horizontal tubular boilers, connected to a 500-horse-power engine. Light and power are furnished for the city of Burlington and the village of Winooski.

Two hundred and fifty arc, 6,000 incandescent lights and 37 motors developing 350-horse-power are used at present, with a probability of more motors and of larger capacity being added soon. No small amount of credit is due the Vermont Electric Company, and especially its general manager, Dr. Walter S. Vincent, for the successful installation of this plant, as it really was the pioneer to demonstrate in Vermont that electricity could be successfully generated by water-power and transmitted for commercial purposes.

Capital is finding these forms of investment to be both safe and remunerative, and it is safe to predict that in 1898 Vermont will see marked advancements in electrical development.—Manufacturers' Gazette.

NEW ELECTRICAL INCORPORATIONS AND BUSINESS CHANGES.

Woodsfield, Ohio.—Monroe Telephone Co. has been incorporated with a capital stock of $1,000.

Trenton, Ill.—Trenton Light and Power Co. has been incorporated by J. C. Eisenmayer, Louis Reimann and Frank Leonhard; to operate light, heat and power plant. Capital stock $8,000.

Crestline, Ohio.—People's Light and Power Co. has been incorporated with a capital stock of $30,000.

Chicago, Ill.—Western Telephone Manufacturing Co. has been incorporated by M. B. Kennedy, W. A. Bisland and S. C. Platt; to manufacture telephones. Capital stock, $2,000.

Saginaw, Mich.—The Saginaw Suburban Railway will build an electric line about 50 miles long.

Shell Lake, Wis.—City Clerk may be addressed concerning electric power and light plant. The business men are considering a proposition from the D. & D. Electric Manufacturing Co., of Minneapolis.

Eldora, Colo.—A telephone line will probably be established.

Bucyrus, Ohio.—The Bucyrus Telephone Co. has been incorporated with a capital stock of $30,000.

Huntsville, Ala.—The Huntsville Electric Co. has enlarged its plant.

Corunna, Mich.—Mr. Holly will put in an electric lighting plant.

Newark, N. J.—The Western Electric Appliance Co. has been incorporated by Edward Weston and others. Capital stock, $750,000.

Versailles, Ky.—The Versailles Telephone Co. has been incorporated with B. B. Smith, president; Charles S. Powell, vice-president and W. R. Proctor, secretary-treasurer; to establish a telephone system. Capital stock, $5,000.

Milwaukee, Wis.—The Uihlein Bros. have been granted permission to construct and maintain an electric conduit under the surface of Grand ave.

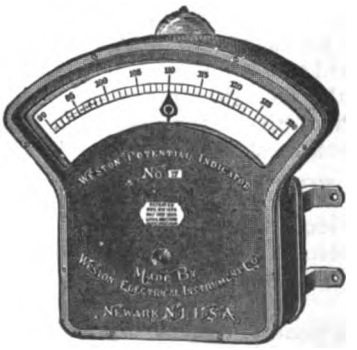
Detroit, Mich.—The New State Telephone Co. has petitioned for permit to operate a telephone system in this city.

Nebo, Ky.—Dr. Ferguson is arranging for the extension of telephone line from Nebo to Silent Run.

Wise, Va.—John E. Hale is interested in the proposed erection of electric light plant.

REMOVAL NOTICE.—Believing that our former location, 511 W. 13th street, was inconvenient for our customers, we have removed our place of business to the electrical district, 107 Liberty street, where we will be pleased to see our patrons. Eureka Tempered Copper Works, 107 Liberty street, New York City.

WESTON STANDARD ILLUMINATED DIAL STATION INSTRUMENTS.



THESE INSTRUMENTS are based upon the same general principle and are just as accurate as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger, and the working parts are inclosed in a neatly designed dust-proof cast-iron case, which effectively shields the instruments from disturbing influences of external magnetic fields.

WESTON ELECTRICAL INSTRUMENT CO.

114-120 William St., Newark, N. J., U. S. A.

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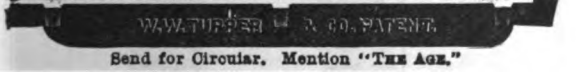

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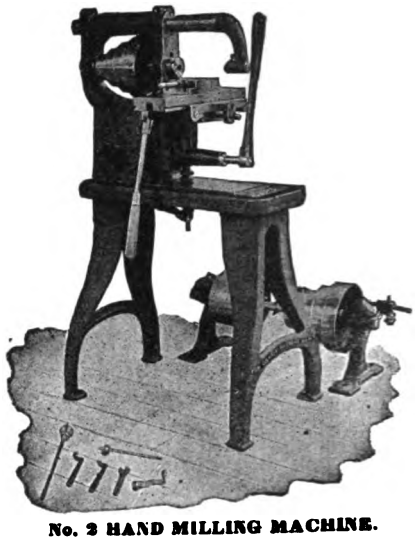

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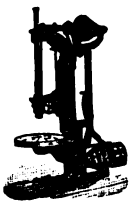

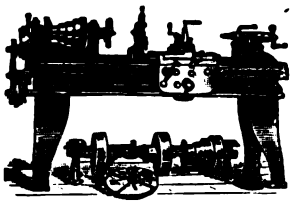

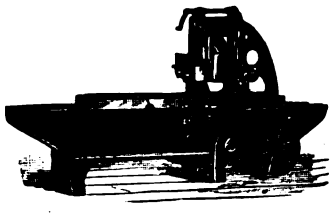

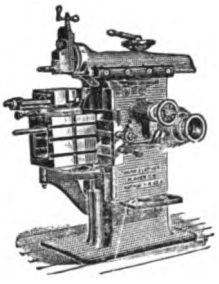

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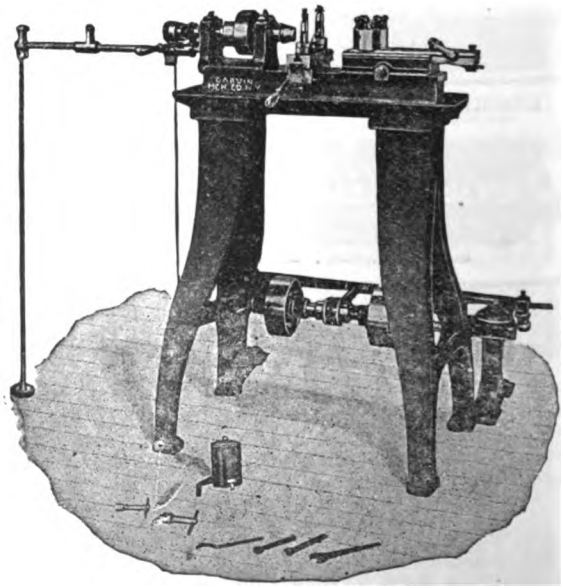

No. 60 SCREW MACHINE (WIRE FEED).

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The Electrical Age.

VOL. XXI—NO. 13 NEW YORK, MARCH 26, 1898 WHOLE NO. 567

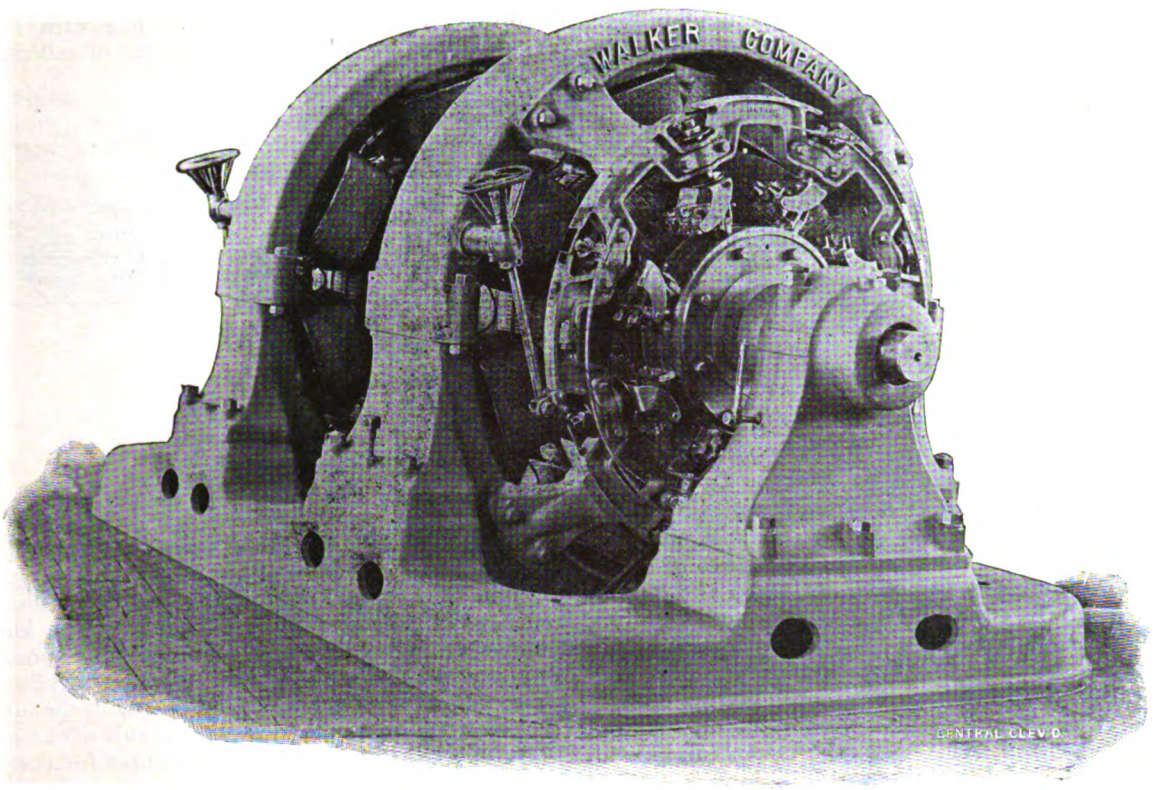

Fig. 1. 400-K. W. Booster.

BOOSTERS.

Motor dynamos, or "Boosters," as they are commonly called, are in reality step-up transformers for direct currents; that is, they give an added pressure to compensate for extra long circuits or portions of circuits in street-car service, electric lighting, or power distribution of any kind; in fact they raise the voltage of a direct current wherever that may be desirable.

The usual form of machine is one with a double field and two armatures mounted on one shaft—the motor armature driving that of the generator. This apparatus is self-regulating, as the main current passes through the generator field and armature in series with the motor, so that, as the load on the main circuit increases, the strength of the field in the booster proper is increased, and the necessary additional pressure is furnished to the booster circuit.

These machines may be wound for any desired increase in voltage, and in the Walker booster the regulation (that is, the ratio of increased pressure to increase of load) is very exact.

The photograph illustrates a 400 K. W. booster built for the Baltimore & Ohio Railroad, and used to furnish additional pressure to the 500-volt current, which is sufficient for the street-car service in Baltimore. The machine delivers the current at 700 volts, and at this pressure it is used to operate the 68-ton electric locomotives which draw the Baltimore & Ohio trains and those of the Royal Blue line through the Baltimore tunnel.

It will be noticed that this machine embodies all the well-known features of design common to Walker apparatus—the celebrated brush-holding device, self-oiling bearings, graceful form, massive construction and general excellence of workmanship.

The arrangement of circuits will be at once apparent from the diagram, Fig. 2. The main circuit from the generators passes through the motor end of the booster with a shunt field and in series through the field and armature of the generator end where the necessary 200 volts extra are added, delivering the current to the locomotive feeders at 700 volts. The ordinary street-car circuit at 500 volts is shown at the left of the diagram.

Fig. 3 is a dimensioned drawing of this type of booster, which is built in six sizes.

Fig. 4 shows a small booster of 35 K. W. capacity, built for railway and lighting service in Lecce, Italy. This is used in connection with a battery of storage cells which are charged from the street-car mains during the periods of light load. The current in the mains is at 600 volts, and it is delivered to the storage battery through the booster at 300 volts. At night, when the load on the car line is very light indeed, the generators are shut down and the line is run from the batteries, the booster re-converting the 300-volt current of the batteries to the 600 necessary for the cars and the few lighting circuits which are fed from the railway mains.

This system illustrates admirably the economy in operation which may be achieved by the use of this type of machine.

ELECTRIC POWER IN MILLS.

At a recent meeting of the South Staffordshire (England) Institute of Iron and Steel Works' Managers, an interesting paper on "The Application of Electricity to the Transmission of Power," was read by Mr. H. W. Ravenshaw, C. E. The president prefaced the paper by remarking that it was a matter of considerable moment to all to be well posted in what was going forward in the world if they were to hold their present positions. They

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all must agree that in the iron trade they could not expect any material rise in price in the near future, and, therefore, what they had to look to was greater economy and more perfect methods of working.

The author, in his paper, said managers of works and manufacturers generally were beginning to realize the fact that the old methods of transmission of power to their machinery were in many cases extremely wasteful, and that the electric motor was far cheaper in the end than the line shafting and isolated steam engines which have been generally employed. For years in an engineering works, mill, or colliery immense quantities of coal were uselessly consumed in wearing out belts and bearings, and in raising steam which was to be condensed in long lines of steam pipes, and perhaps re-evaporated in the cylinders, without any useful purpose. In order to reduce losses electricity was being employed in many cases with great success, a central station being established in the works, and electric motors being employed to drive the machinery, a separate motor being generally used for each machine. Transmission of power by electricity was decidedly economical, the loss in a good dynamo being not more than 7 per cent., and another 5 per cent need only be lost in the cables within a radius of, say, half a mile, and the loss in the motor and gear for reducing the speed to, say, 100 revolutions per minute need not be more than 12 per cent.

These figures gave a total efficiency of about 76 per cent., and with boilers evaporating eight pounds of water per pound of coal, and engines using 24 pounds of steam per b.h.p. hour, a consumption of less than four pounds of coal per b.h.p. delivered to machines could be obtained.

The continuous current motor had many good points. The question of pressure to be employed was an important one, as the first cost and efficiency of working depended to a great extent on a good selection. In collieries 500 volts were generally employed, and with this pressure several hundred horse-power could be transmitted over a radius of at least one mile without difficulty. In a works covering a comparatively small area, however, both lighting and power could be obtained from a 200-volt circuit with economy, incandescent lamps being now made to work up to 220 volts. A good many works and mills had been fitted for 100 volts, but there was no advantage in so low a pressure, while with 200 volts a very great saving was made in the cost of cables.—Amer. Mfr.

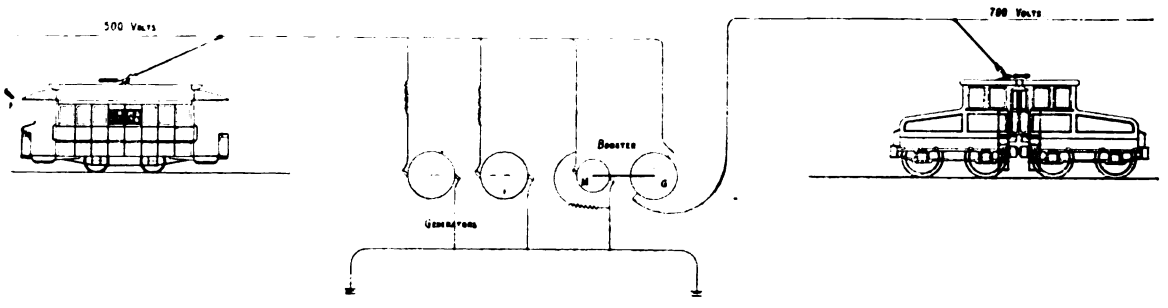

Fig. 2. Booster Connections.

ALUMINUM.

During the year 1897 prices have been further reduced from 37 cents per pound at the beginning to 33 cents at the close of the year. The same tendency ruled on the continent of Europe; from 2.60 marks per kilo at the commencement of the year—equivalent to about 28 cents per pound—it declined to 2.40 marks per kilo—equivalent to about 26 cents per pound—for large quantities. The reduction in values was the result of a largely increased production. The official figures for the year 1896 showed a production in this country of 1,300,000 pounds. The production for the year 1897 will show that the same has tripled and amounts to 4,000,000 pounds. The same tendency in the way of production is going on in Europe, and the year 1898 promises a very largely increased output. Our own production of 1897 was markedly in excess of the home demand, and therefore foreign outlet had to be sought, and frequent exportations of importance were made. The reduction in prices has commenced to bring the article in competition with other metals. Taking the price of sheets as a basis, aluminum is relatively cheaper than brass, and will prove a worthy competitor. It will take time to demonstrate this to the trade at large, but as long as the fact exists, it is only a matter of time when success will follow.

Next to brass, copper will feel its influence as a rival for electrical conductors. Aluminum as a conductor for electric current is already in practical use at the Niagara Falls Works of the Pittsburg Reduction Company, and in the Chicago Stock Yards a mile of aluminum wire is in use as a telephone wire. Both, as far as known, give full

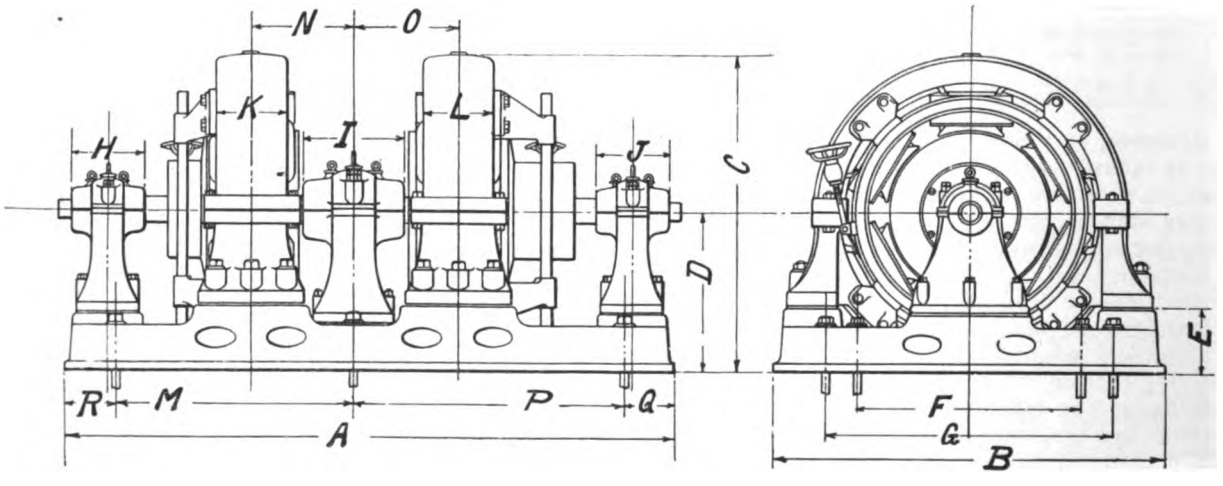

Fig. 3.

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satisfaction. If reports to hand are correct, the near future will bring forth new developments, bringing this metal into more extensive use for electrical purposes.

ELECTRICAL EXHIBITION NOTES.

MR. FRED CATLIN, the manager of the telegraphic tournament, has completed the preliminary arrangements for that contest and has arranged the classes. Circulars on the subject will be ready this week for general distribution, and there is already a great demand for information on the subject from all parts of the country. Mr. Catlin informs the exhibition management that the entries will probably be more numerous than at any other tournament that has occurred, and thinks that some of the records will be phenomenal. It is proposed, in addition to the regular contest, to have interesting exhibits of telegraphic skill in novel directions. Mr. Jesse H. Bunnell, the electrical manufacturer and veteran operator, is taking a deep interest in the contest, and has volunteered to equip the whole stage with the necessary apparatus for the competition in the shape of keys, sounders, batteries and auxiliary appliances. Mr. Bunnell is desirous to have a separate prize offered for an "old-timer's class," and has already entered himself for that contest. He has the reputation, dating from the war, of being an unusually fast and skilful operator.

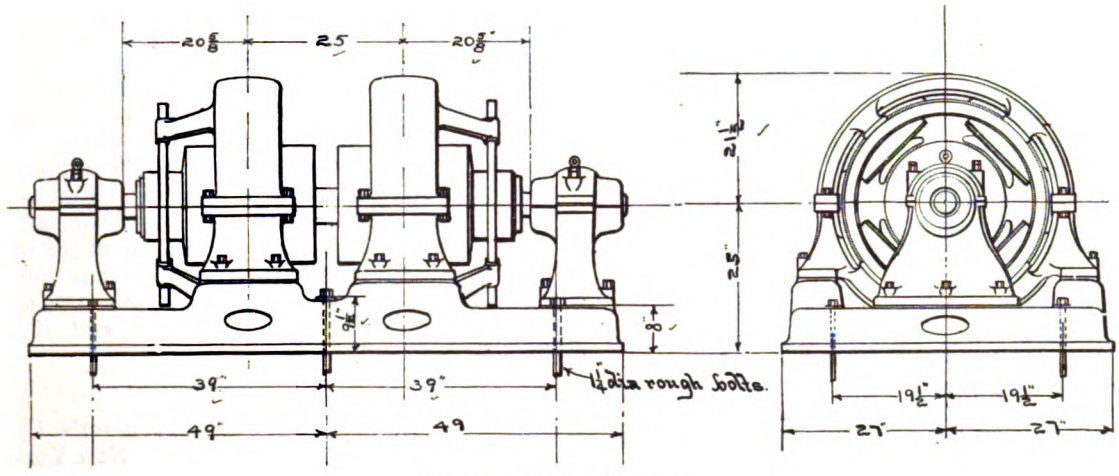

Fig. 4. 35-K. W. Booster.

Mr. H. V. PARSELL, the well-known banker of this city, who has long been interested in electric deposition work, has kindly placed in the hands of his son, Mr. H. V. Parsell, Jr., the electrical engineer, for exhibition at Madison Square Garden during May, a marvellous collection of galvanoplastic work, done during a long series of years. It may be doubted whether any other amateur could possibly show anything approaching this remarkable collection in beauty and interest. It will not only include several striking pieces, as large as 25 inches by 25, and reproducing celebrated works of art and famous men, but will comprise large numbers of coins, medals and fac-similes of antique gems. The most extraordinary part of this beautiful collection, however, will be that which embraces the reproductions from natural objects. It is safe to predict that there will be a crowd around these exhibits all the time. The manner in which they are made, for example, is of deep interest.

There are, for instance, snakes and frogs which have been made to the life and from the life. The snake is etherized under a bell jar, then taken out and greased with sweet oil and replaced in the bell jar, while a sufficiency of thin plaster is mixed with warm water. The snake is then placed on a glass plate and posed. Around him is built an enclosure of four square bars, and the plaster is slowly poured over the snake, the bars confining the cast in a rectangular shape. When the plaster is hard it is freed from the sticks and glass plate and the now defunct reptile is carefully removed, tail first, from his intaglio impression. The plaster cast thus obtained is rendered water-proof by immersion in molten paraffiine. A metallic conducting surface must now be given to the interior of the cast. This is done by moistening the surface of the mould with a solution of silver nitrate and by exposure to sulphuretted hydrogen, precipitating the silver on the cast. A conducting wire is now fastened around the edge, and the mould is carefully suspended in the depositing bath. A good, firm coating takes about three days to form, and then the mould is softened in boiling water and carefully broken off.

PEOPLE HAVE OFTEN HEARD of the incinerating effects of high-frequency currents, but rarely get any practical demonstration. The attention of the electrical and popular press has lately been drawn to the grim fate of various birds that had, in an unfortunate moment, perched on some of the high-tension wires of the power transmission circuits in California. Mr. Geo. P. Low, the well-known electrical engineer of San Francisco, has preserved the remains of two eagles, some storks and other birds, which had short-circuited part of the current while sitting on the wires, with the result of leaving only their beaks and talons, not a vestige of their bodies or feathers being discovered. Mr. Low is forwarding these curious relics to the Electrical Exhibition, where they will be mounted in such a position as to show how the thing happened and just what happened. It will be the first exhibition of the kind that has ever been made.

IT IS PROPOSED at the Exhibition to have amongst other railway apparatus, a working model of track intended to demonstrate the operation of the third-rail system as applied to steam railroads. Colonel N. H. Heft, the electrical engineer of the N. Y. N. H. and H. Railway Company, whose work is so widely known in connection with the successful third-rail line between Hartford and New Britain, Conn., has very kindly placed at the disposal of the management blue prints showing the construction of the track and some of the actual material used. The model track, from 50 to 100 feet long, single and double and about five inches gauge, is now being constructed on Col. Heft's plans, and will be shown in actual operation during the continuance of the show, the details of the track being imitated as closely as the conditions will allow. Over this track a train of cars will run to and fro, continually showing how the current is picked up and delivered to the motor and how the switches and signals are included in the operation.

San Francisco, Cal. — Electric Mortar Hardener Co. has been incorporated by James McKendrick, Abraham Blumenthal, William Loewi, J. C. Meyerstein, and L. F. Humphrey. Capital stock, $1,000,000.

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TRADE OPPORTUNITIES IN SIAM.*

Siam offers a field for development which is not appreciated by American exporters and manufacturers. During the coming year special effort should be made to increase the trade of the United States with this rich and prosperous kingdom of southeastern Asia. A critical period is approaching, and the results thereof will determine the control of Siamese foreign trade.

Too little is known about this country in the United States, or, I might say, there is too little respect for it as a factor in Asiatic trade. True, it is small compared to our vast area and population, but it is deserving of far more attention than it receives. It is of more consequence in the political world at this writing than it has ever been before, and its commerce is growing. Exporters of Europe have fully awakened to the importance and possibilities of Siam's markets.

After a residence of four years in Siam, I think that here is one of the best opportunities for the United States to build up a trade that is afforded anywhere in the world, considering, of course, the population and area. But all efforts to induce American exporters to enter these markets have been unsuccessful. Letters have come in unlimited numbers, to all of which careful attention has been given; catalogues have arrived and been distributed where they would do the most good; questions asked have been answered in detail; and many reports, general and specific, have been sent to Washington and duly published for the benefit of the exporters and manufacturers of the United States; but still there is a most discouraging lack of interest. This interest should be evidenced by sending to Bangkok experienced and capable representatives to carefully investigate the field, secure trial orders, and establish reliable agencies. In this connection, three facts are worthy of note: First, not more than six qualified representatives of American houses have visited Siam during the past three and a half years; second, almost without exception those that have come have been surprised at the extent and opportunities of the market, and have gone away with satisfactory orders, or, at least, with sufficient to pay expenses; third, in the same period no less than one hundred capable representatives of European firms have visited Bangkok, and, in 90 per cent. of the cases, have done very well.

If an American house which deals in the class of goods exported to foreign lands is strong enough to employ one or more travelling agents in the United States, it can afford to send a capable man to the far East to take charge of the entire field, from Yokohama to Singapore, which would include Bangkok. If he did not pay expenses, and so caused loss to his company, it would either be because he was not qualified by experience and training, or because the class of exports he was endeavoring to market would not be suited to the field. If the products he offered were in demand, his trip should result favorably.

Catalogues are valuable in their way—invaluable, in fact—but too much reliance is placed on them. They do not discuss the matter with the buyer; they do not answer all his inquiries; they do not obviate his objections to trying a new firm, a new class of goods, or to giving up his relations with some European house which has supplied him for years. Most merchants at home have already read this observation, but I will add this comment: If firms which are rich enough to publish the elaborate catalogues, which they issue annually, would devote even a small portion of that expense to sending energetic, educated, and tactful representatives to the far East, they would obtain far more substantial returns.

One great point about Siam, which has been repeated time and time again in my reports on the opportunities for American trade, I now wish to call to the attention of American merchants for the last time, although it is quite probable that my successor will make the same recommendation. It is, that there is unquestionably an excellent and practicable opening in Bangkok for the establishment of a large, strongly capitalized American importing and exporting firm. The field is here, the business is here, present conditions are favorable, and the outlook for such an investment is good. All the important European houses (of which there are many) which have been well managed have succeeded financially, paid satisfactory dividends to stockholders, and are today enlarging rather than curtailing their operations. A United States company would run little or no risk in opening a house at Bangkok, because a retail department could be established which would pay all current expenses of employees, clerk hire, rent, lights, insurance, etc. I seldom discuss American trade opportunities with a foreigner or native whose opinion is reliable, without reference being made to the absence of a representative American importing and exporting house. The concensus of opinion is that, with good executive control, it would pay handsomely. It would be best if a company already permanently established in Japan and China would operate an extensive branch here; but if a new firm were organized in New York or San Francisco with sufficient capital—say $100,000 to $200,000 gold, with only a third or half paid up to begin business—and with a local manager who has had experience in dealing with Asiatics, I am confident that it would not only pay expenses from the start, but a dividend of 10 to 15 per cent. at the end of the second year.

*John Barrett, Minister Resident and Consul General, Bangkok.

Proctor's Theatre,
New York.

Swann Manufacturing Company,
New York City, N. Y.

Gentlemen:—I find that your coloring enamel and frosting which you furnish for the lamps we use in our Living Picture Exhibition and other stage lighting, gives excellent satisfaction. It has proved superior to genuine colored glass lamps, giving much better light. I have in the past ten years tried many kinds of coloring enamel, but the Bohemian is the best and the finish is as smooth as natural glass.

Yours truly,
G. W. Whittaker, Electrician,
Proctor's Theatre.

We hear through the columns of The Engineering and Mining Journal that Dr. Carl Auer von Welsbach has recently completed some important investigations with regard to the application of the rare earths to the incandescent electric lamp, and he claims to be manufacturing filaments in which these earths are used. In this way he obtains an increased light with the expenditure of much less current. The patents are not yet published, and neither the inventor nor the company controlling the patents is inclined to give any details at present. A few months ago the English Welsbach Company was reorganized on a larger scale and additional capital obtained. At the time, the public and the press were inclined to deprecate this reconstruction which they called watering, but now the reason for it becomes apparent.

An International Magnetic Congress will probably be held either in 1899 or 1900, at which those interested in the study and recording of the phenomena of the earth's magnetism will have an opportunity to exchange views and decide upon definite plans of observation for the future.—Mfrs. Gazette.

Meyersdale, Pa.—Meyersdale Electric Light, Heat and Power Co. has been incorporated, with a capital stock of $10,000.

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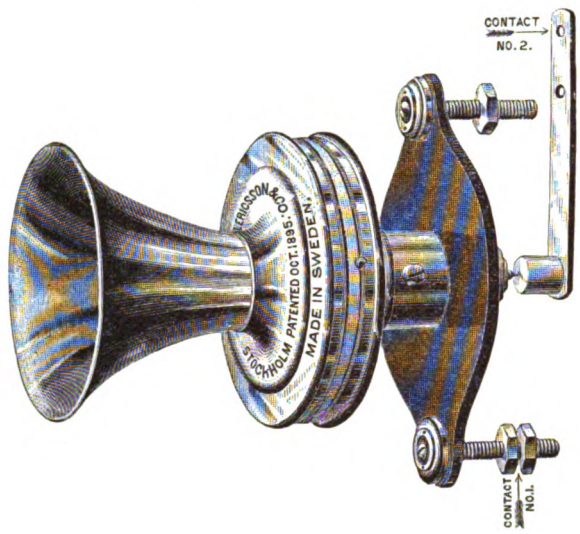
A NEW TELEPHONE COMPANY.

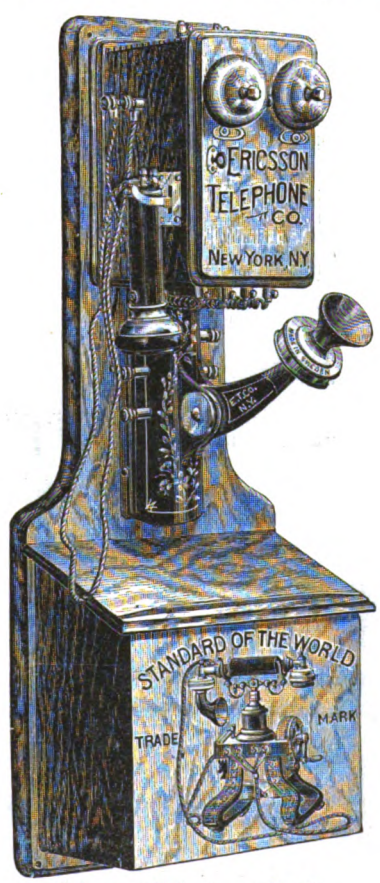
The Ericsson Telephone Company was organized a few days since in New York to succeed the firm of Smith & Patterson, sole representatives for the genuine L. M. Ericsson & Co.'s Swedish telephones. These goods have been sold in all parts of the United States, and have been found to be all that is required of a first-class telephone, and to give absolute satisfaction in all particulars. They are built on mechanical principles, and every detail is looked after with as much care as though it was a watch. The maintenance of the Ericsson telephones is nothing, after they are once installed, and they are worth every dollar of their price.

In addition to importing, they will manufacture a domestic instrument of the regular type, double and single cell battery boxes, with and without arm, using the Ericsson imported receiver and transmitter, and putting same on the market at the popular price of the best American instruments shown to-day. They have also begun to import the Swedish switchboard. Owing to the heavy demand that Ericsson & Co. have had for the past few years in their foreign trade, they have been unable to allow the sale of any switchboards in the American market, except in a very limited way. They are prepared now to put out a complete multiple system or trunking system, as may be required. All goods will be carried in stock in New York, and orders will be promptly executed and not held over, as the old firm (Smith & Hemming way, No. 10 Warren street) formerly did.



Ericsson Transmitter.

They show, in this reading matter, a few cuts of their latest instruments, such as the new 1898 long-distance microphone, with back and contact to go on any style of telephone manufactured; also microphone mounted on arm, as well as long-distance exchange set, and, in addition thereto, the latest switchboard that is manufactured



Ericsson Telephone Outfit.

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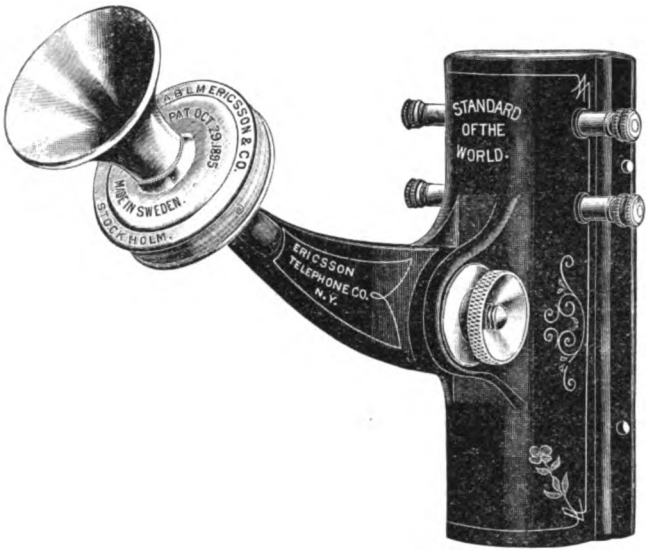
by Ericsson & Co., one without cords and jacks.

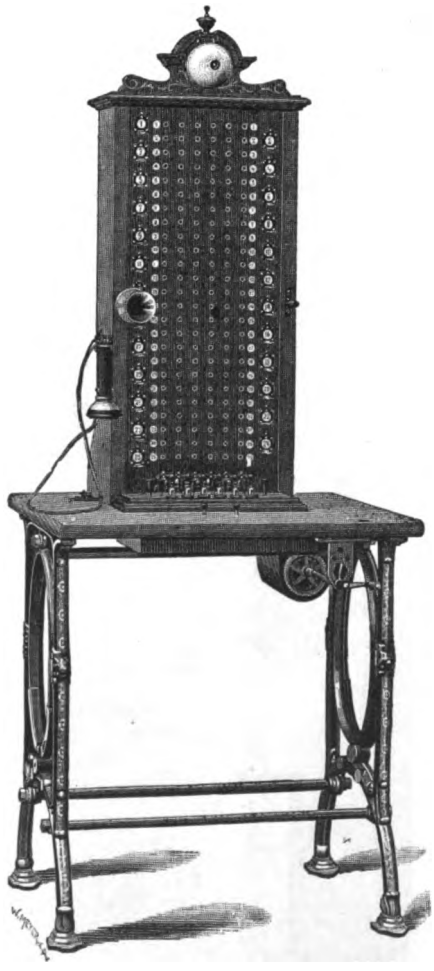
They are preparing now, and will have out in about three weeks, their new catalogue (5th edition), which will be sent out to the trade on application. In bringing out this new catalogue, the company will introduce some novel inventions in the telephone line, such as breast-plate transmitters and receivers, an all-metal telephone, their famous $375 combination wall and desk telephone, lightning arresters that require no plugs and quite a few novelties.



Microphone Mounted on Arm.

THE WALKER COMPANY, of Cleveland, Ohio, recently finished the largest direct-current generator ever built. It was contracted for by the Brooklyn Heights Railway Co. of Brooklyn, N. Y., and its total weight was about 150 tons, the weight of the armature alone being nearly 50 tons. Orders are now being filled for 20 motors for the Metropolitan West Side Elevated Railroad of Chicago, for forty double equipments for the Union Railway of New York, and 100 double equipments, including controllers and motors, for shipment to Dresden, Germany.

Wilmington, Del.—The Wilmington & Chester Traction Company has been incorporated by a company with a capital stock of $2,000,000; to build and operate electric trolley lines in Pennsylvania, Delaware, or elsewhere.



Swedish Switchboard.

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The Electrical Age.

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NEW YORK.

NEW YORK, MARCH 26, 1898.

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ELECTRICITY IN WARFARE.

The present crisis between this country and Spain will bring into use the latest forms of protecting devices and electric armaments such as have lain in abeyance for the past five years. Some of these appliances, used for attack or defence, will prove very formidable. In naval warfare the search-light, sweeping the sea for miles around, will prove an able means of defence.

Our modern war vessels are equipped with powerfnl search-lights, which will reach a distance of from two to twelve miles. Modern practice has shown that the best system to employ in order to keep the vessels free from attacks from torpedo boats is one involving the use of many search-lights, because, in the interval during which one part of the sea is dark and another part illuminated, a torpedo boat could glide forward from a distance of two miles and successfully blow up the vessel. It is, therefore, necessary to sweep the ocean with the luminous rays and keep every inch of it as far as possible under inspection.

In the control and management of the fish torpedo we deal with a device depending absolutely upon electricity for its propulsion, guidance and subsequent explosion. The torpedo is projected from a steel tube at the enemy's war vessel, and when in the water guided by its own devices. It forms a powerful means of attack, and with the proper number a given line of advance may prove impregnable.

Naval vessels frequently make use of the electrical log for measuring the speed of the vessel, and although such a device will not give the velocity at any instant, it will enable the executive to judge of the rate of progress in any given case. Battles in the future between civilized nations may become to a large extent a war of push-buttons—the pressure on a key being sufficient to set in action tremendous forces or deliver a volley of projectiles of deadly effect. The U. S. dynamite cruiser "Vesuvius" discharges projectiles from pneumatic guns which are subsequently exploded by a charge of electricity. Each projectile carries six hundred pounds of highly explosive material and will wreak a terrible vengeance wherever it strikes. A few dry cells are carried within the projectile and raise to incandescence a platinum wire which is surrounded by fulminate of mercury, thus causing an explosion of the main mass of material. This last method is employed whenever explosives, such as dynamite, gun cotton, etc., are to be dissipated—a detonating charge being found most effective.

In submarine work for boats built on the plan of the famous "Nautilus" of Jules Verne, such as the Holland submarine boat, experience has shown that electricity is the only force that can be successfully employed. A war vessel will find great difficulty in protecting itself from so invincible a destroyer as a well constructed and properly controlled torpedo boat. Its power of doing evil is almost beyond calculation, and when in operation it may remain at a safe distance and project its deadly missile against the comparatively unprotected bottom of the most massive war vessel ever built.

The Fiske range finder represents in many respects the crowning success of this age, as it enables an operator far removed from the scene of battle to train a swiftly moving explosive device with unerring accuracy upon any given point within its reach. A fish torpedo may be directed along given lines to an enemy's ship and steered with a touch of the finger from shore with almost absolute certainty.

The control of submarine mines from any given point along the shore is so effective in case of war as to absolutely prevent entrance by an enemy into any harbor or body of water. It is but necessary to make an extensive employment of these means and a coast will be safe from the ravages of marine assailants, its maritime ports ably protected and its freedom from immediate danger apparent and pronounced. On land the telephone and telegraph have their parts to play, and a new institution, the war balloon, gives to an observer therein a bird's-eye view of the country of the utmost value. Communication between this aerial device and the earth can be easily carried on and the movements of an enemy laid bare in detail.

It is but little for us to say that the future of war and even its possible discontinuance willl depend greatly upon the development of electrical devices in naval and land warfare. It may be as Bulwer-Lytton has said "that when each nation is capable of exterminating its neighbor war will cease, with its horrors, misery and bloodshed."

Mobile, Ala.—The People's Light and Heat Company has been organized by J. W. Whiting, Leopold Lowenstein, S. T. Prince, James K. Glennon, R. H. Clarke, and others, for the purpose of lighting and heating by the Kitson hydrocarbon system. Capital stock, $100,000.

Detroit, Mich.—John C. Shaffer, of Chicago, is the organizer of a new company who will build a line from Detroit to Toledo, to be operated by electricity. He has associated with him a syndicate of capitalists of Chicago, Pittsburg and Detroit.

Fitzgerald, Ga.—The Mayor may be addressed concerning erection of electric light plant, for which $30,000 worth of bonds will probably be issued.

Bay St. Louis, Miss.—The Mayor may be addressed concerning erection of electric light plant, for which about $40,000 worth of bonds will probably be issued.

Pocomoke, Md.—Dr. W. H. Walters may be addressed concerning construction of telephone system.

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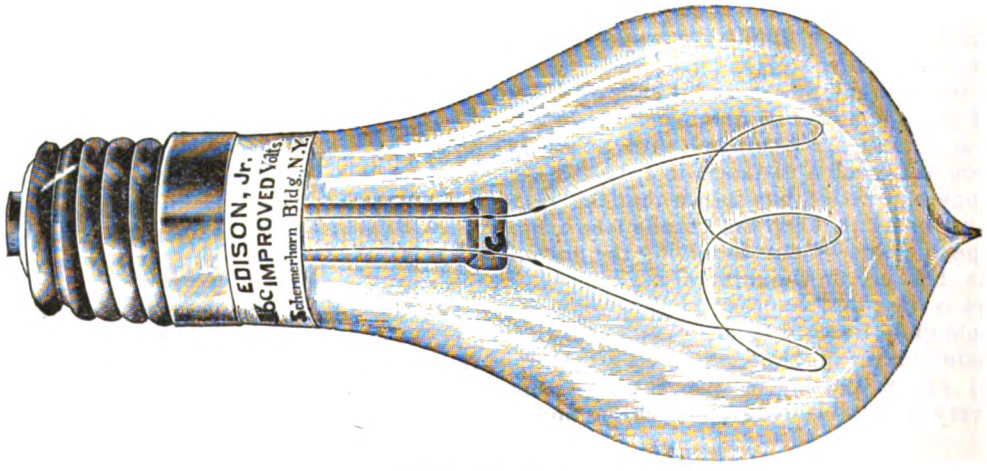
THE THOMAS A. EDISON, JR., INCANDESCENT LAMP.

The Edison, Jr., lamp is being used by all the great lamp consumers of New York City and its vicinity, as well as throughout the United States. Its excellent qualities, which include long life and high efficiency, have made it known to all electrical contractors and supply dealers. In a recent test, published in these columns, a fifty-five volt Edison, Jr., lamp was kept burning on a 117-volt circuit for twenty-five minutes without apparent injury.

The Watt consumption per candle-power of the Edison, Jr., lamp, combined with its long life, have placed it first in the eyes of station men and engineers in charge of private plants. Thomas A. Edison, Jr., has lately returned from an extended trip. His business was carefully attended to during his absence by Messrs. Stilwell and Holzer, two very well known lamp experts. They have so largely developed the lamp trade that orders can hardly be filled with sufficient rapidity. They will be compelled to enlarge their works to meet the demand. The Edison, Jr., lamp was only produced and marketed after a long series of important tests.

Mr. Edison, Jr.'s, unequalled laboratory experience in lamp construction has enabled him to give to the world a light producer whose reliability, efficiency and general superiority to other lamps can be proven by test and usage. Thomas A. Edison, Jr., is one of the greatest specialties in incandescent lamps, and fully understands the requirements of the trade. The address of Thomas A. Edison, Jr.'s New York office is 96 Broadway.

Thomas A. Edison Jr.



Edison Jr. Lamp.

DEMAGNETIZING WATCHES.

A simple method of curing a magnetized watch consists in hanging it from a string, which latter is twisted as tightly as possible, and then holding the string and watch near a dynamo or strong magnet. The watch is then released, and, of course, begins to spin and while doing so is gradually carried away from the dynamo and out of the magnetic field. The demagnetization is due to the rapid alternations of the poles of the magnetized parts in a magnetic field, that is decreasing in intensity. This is well known to be a thoroughly reliable method.

Charleston, S. C.—The Charleston Light and Water Co. has been incorporated by Samuel Lapham, Charles R. Valk, W. H. Welch, A. G. Rhett, H. F. Bremer, George I. Cunningham and others. Capital stock, $500,000, with privilege of increasing to $3,000,000.

Winchester, Tenn.—S. M. Alexander is interested in the establishment of a telephone system.

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ARC LIGHTING AND ARC LIGHT CIRCUITS.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

When a motor is to be installed certain precautions must be observed in order that no injury from fire can result and no danger from shock exist.

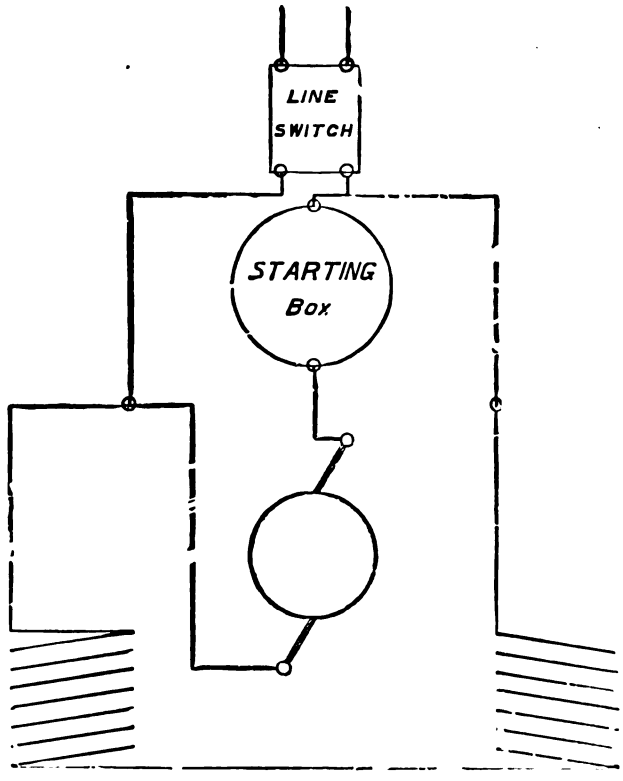
The fire underwriters of every large city impose limitations upon contractors and prevent them from doing careless work. It is usual to mount the motor upon a fireproof foundation and have a large pan underneath to catch the oil drippings. A zinc pan is frequently used for this purpose, the motor being mounted in the centre of it. The starting box must be of slate and have under it a large sheet of asbestos paper. The fuse blocks, devices used for the protection of a line, must be covered to prevent the dangers of fire from the vaporized metal.

In total, the installation of either motor or dynamo must be so made that the risks from shock and fire are entirely removed. A low voltage motor or dynamo does not introduce much danger from mere shock; and, up to about 400 volts the person in charge is secure, but the chances of fire always exist.

A loose-hanging connection, a short circuit on the line, a bad ground, etc., may bring about this danger unless regular tests are made to keep the line clear and dynamo insulated. A lightning arrester is a very necessary adjunct to a plant having an outside line. Frequently a station is destroyed by lightning, according to report. This may not be true, although lightning is in many cases the original cause. Lightning by striking a line, or dynamo through the line, usually sparks across every available gap.

An arc is thus started and continued by the generator itself. It is thus very likely that in many instances the burning is done by the dynamo current, although the original cause—lightning—has long since disappeared. Protectors in many cases fail to protect because there is a certain defect in lightning arresters, and a peculiar oscillatory nature to the lightning discharge that must be better understood before arresters can be used with certainty in every case.

Both dynamo and motor are protected from an overflow of current by means of a safety fuse or cut-out. This is simply a piece of lead wire inserted in the circuit and of such a size that a flow exceeding the regular amount will melt it and open the line. The danger being over it is then replaced by another piece. Good insulation to either dynamo and motor, good safety devices, in the shape of either cut-outs or lightning arresters and a drip pan to catch the oil, comprise the essential elements of good installation.



Connection of a Shunt Motor.

Arc Lighting Machines.—Arc lighting machinery differs from incandescent in one or two respects.

As a rule arc light machinery is of higher pressure; it is also series-wound and therefore regulated differently, and in additon the line is a simple series circuit. The high tension or direct-current dynamos, as they are often called, require an attendant, only valuable if experienced, and ready to grasp a situation at times filled with deadly danger.

The care of high tension arc machinery is not the pleasantest occupation in the world. In an arc dynamo, the armature of field winding form one continuous circuit in addition to a long outside line.

Pressure of Arc Lamps.—The string of arc lamps connected to the outside line each require 50 volts. The pressure developed by a machine is automatically regulated according to the number of lamps in circuit. A 50-light machine would generate $50 \times 50 = 2{,}500$ volts, if fully loaded, yet it will give anything less than that if so required.

Regulation.—To control the voltage of any dynamo it is necessary to vary either the

speed,
armature turns, or
field strength.

In practice the speed cannot be changed, as the engine runs at a fixed number of revolutions per minute. The field strength may be varied, or the armature controlled so that its full pressure is not collected at the brushes. The two methods employed, therefore, may be defined under the following headings:

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Regulation of field,
Regulation of armature.

By shunting the current of the field on and off automatically, will supply more or less lines of force to the armature.

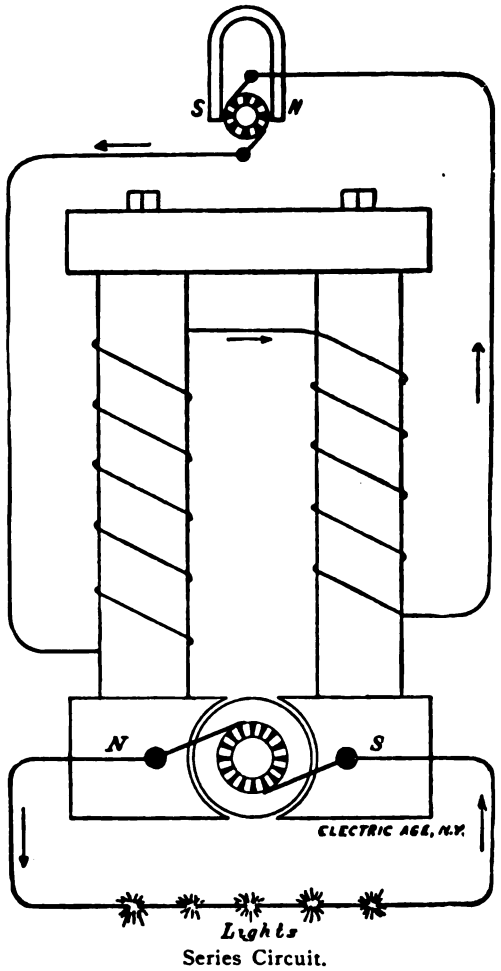
An electromagnet may do this if governed by the outside line; when the pressure is too great, it is reduced by decreasing the field automatically, and the current diminishes likewise to its normal value; the converse is also true.

We are now prepared to enter into a general classification of all continuous-current dynamos, namely:

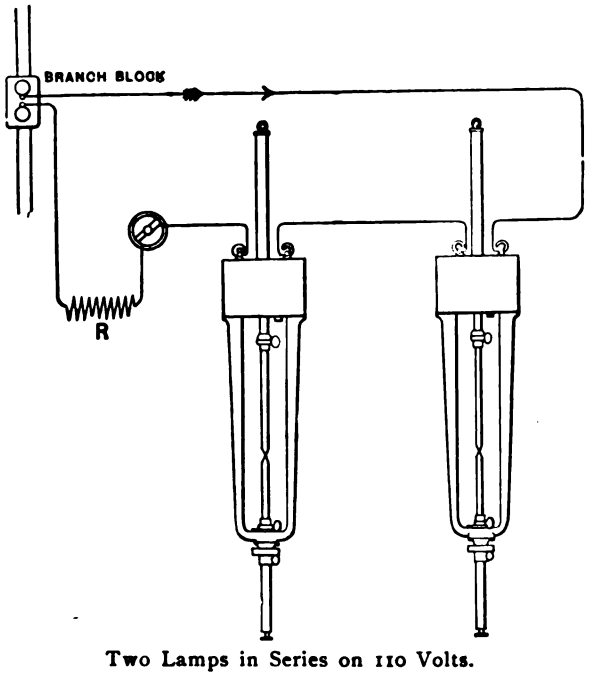
Constant current and
Constant potential machines.

The object of all arc light high tension systems is to preserve a constant current of about 10 amperes and regulate the pressure to the number of lamps used to the extent of just 50 volts apiece. In incandescent dynamos the pressure is kept constant and the current varied to suit the number of lamps.

The regulations of each is, in one case, arc lighting, with reference solely to the current; in the other, incandescent lighting, to the pressure. Therefore, shunt-wound or incandescent dynamos and series-wound or arc-



Series Circuit.



Two Lamps in Series on 110 Volts.

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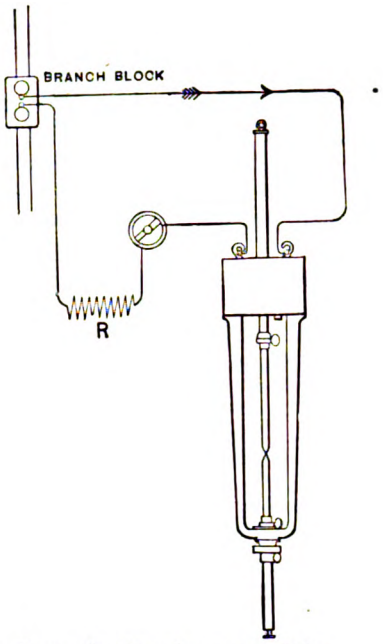
light dynamos are strikingly different in this respect. Dynamos that supply incandescent lights are used for arc lighting also. They obtain their current in shunt from the main current, and are treated like large incandescent lamps in consequence. For long-distance lighting, or the illumination of straggling towns, high tension systems are cheapest.

The regulation of arc systems by means of a special device affecting the armature are most popular. By shifting the brushes on a commutator, the pressure may be varied from nothing to its highest value. If this change in volts is in exact correspondence with the load or number of lamps, then the purpose of automatic regulation is fulfilled. This is also done by means of an electro-magnet in series with the line. When the load is lessened by lamps being removed the pressure, acting through a decreased resistance, increases the current momentarily; this strengthens the magnet, and it pulls the brushes over to a point of lower pressure. These positions of the brushes and volts required for lamps must correspond. The brushes must not move too far or too little, but must be adjusted to touch at the required point of the commutator.

This is practically equivalent to changing the turns on the armature. Therefore, it is seen that the methods of arc light regulation depend upon either a change in field or in effective turns.



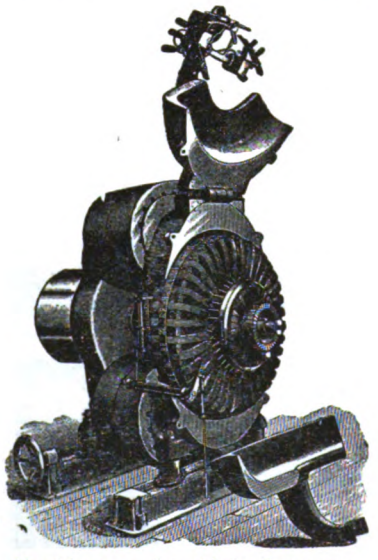
Arc Lamp in Circuit on 110 Volts.

QUESTIONS FOR REVIEW.

(1) What precautions are taken in installing a motor?
(2) Why is a lightning discharge dangerous in a station?
(3) How are power lines protected?
(4) How many volts are required per arc lamp?
(5) By what means is the voltage of any dynamo regulated?
(6) What general methods are employed in arc-light regulation?
(7) What is a constant current?
What is a potential?

NEW YORK NOTES.

The Metropolitan Electric Construction Company is now doing all of the installation work of the Sprague Electric Company, an agreement to that effect having been recently closed. The announcement was made in a striking two-color circular by the Sprague Company, in which circular it was pointed out that the construction Company would not only contract for installation and



Hochhausen Arc Light Dynamo.

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maintenance of Sprague machinery but of any other machinery as well. The offices of the Construction Company, as well as those of the Sprague Company, are in the Commercial Cable Building. The officers are W. D. McQuesten, president and general manager, and Mr. Wallace E. Carver, treasurer.

The organization of the Sprague Electric Company, which our readers well know, was formed by the consolidation of the Interior Conduit & Insulation Company, and the Sprague Electric Elevator Company, is being rapidly perfected. The offices of the company now occupy practically the whole of three floors in the Commercial Cable Building. The company recently secured a suite of rooms in the Marquette Building, Chicago, which will be in charge of Mr. Millard B. Kitt and Mr. E. B. Kittle, long identified with the company. Well-known electrical men and houses are being rapidly secured to represent the Sprague Company in various sections of the country, and the organization bids fair to be a remarkably strong one in every way.

An Advertising and Press Bureau is one of the new Departments of the Sprague Company, and it has been installed in a suite of rooms on the 10th floor of the Commercial Cable Building.

The Stieringer reissue patent No. 11,478 (original No. 259,235) on Electric Light Fixtures and Combined Gas and Electric Light Fixtures was sustained on March 2d, inst., by the United States Circuit Court of Appeals of the Second Circuit, in the suit of George Maitland against the B. Goetz Manufacturing Co.

L. E. FRORUP, of Schiff, Jordan & Co. N. Y., is scouring the West and will return with a book full of orders. They control the original "ELECTRA" arc Carbon Works of Germany.

CARD ELECTRIC CO., of Mansfield, O., are giving away to all who send a business card a fine paper weight. They make all sizes and styles of dynamos and motors.

THE MANSFIELD TEMPERED COPPER CO., of Mansfield, Ohio, are giving away fine paper cutters. They are made of tempered-copper segments for dynamos, motors, etc. W. T. H.

NEW ELECTRICAL INCORPORATIONS AND BUSINESS CHANGES.

Greensboro. Ala.—Louis V. Massey can give information concerning erection of electric light plant.

Baltimore, Md.—James F. Bohen will put in an electric light plant for the purpose of lighting his hotel and grounds near Stevenson Station.

Bartlett, Ohio.—The People's Telephone Company has been incorporated with a capital stock of $2,000.

Wilmerding, Pa.—The White Electric Railway; work has commenced on the extension.

Pine Bluff, Ark.—An electric street railway is to be established.

Detroit, Mich.—American Typal Telegraph Company has been incorporated with a capital stock of $50,000.

Caldwell, Ohio.—An electric light plant will be established, and about $7,000 worth of bonds will probably be issued.

Warrenton, Tex.—A new telephone line is being constructed between this city and Roznor, and will be in operation shortly.

Hunter, Miss.—The Hunter & Maharris Telephone Company has been incorporated with a capital stock of $500.

Des Moines, Iowa.—City Clerk may give information concerning electric light plant.

CANADIAN LETTER.

ELECTRIC RAILWAYS.

Ottawa, Ont.—The British American Light and Power Company want power to construct and operate by electricity or other power tramways in Dawson City, Fort Selkirk and other points in the Yukon district.

Winnepeg, Man.—At the next session of the legislature a local company will ask for a charter to build an electric railway from this city to St. Andrew's Rapids, and through the municipalities of Springfield, St. Boniface, Kildonan, St. Paul's and St. Andrew's. The company also propose to construct saw mills, boats, telegraph and telephone lines.

St. Thomas, Ont.—A meeting of the St. Thomas Street Railway Company will be held on March 2d to authorize the issue of debentures for the sum of $50,000.

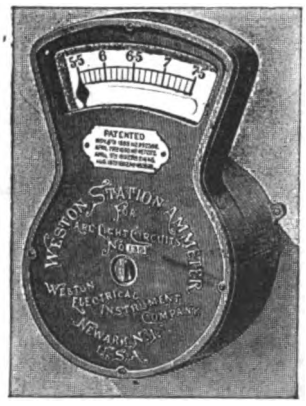
Perth, Ont.—James Fowler, of Arnprior, is reviving the proposal to build an electric railway from Perth to Sanark.

Chatham, Ont.—A proposition is now being considered to build an electric railway to Rondeau Park. C. W. Richardson is one of the promoters of the scheme.

Sarnia, Ont.—It is said that the St. Clair Tunnel Company are considering the conversion of the steam power of the tunnel into electric power. The matter is understood to be under the consideration of Mr. Joseph Hobson, of Montreal, chief engineer of the company.

TECHNICAL SCHOOLS IN GERMANY.

The kingdom of Saxony is perhaps in political abeyance. But it is the leader of the industrial world. Nowhere else is technical skill so highly developed; nowhere else does manufacturing approach so nearly to the rank of a learned profession. Small as the kingdom is it has no less than 111 technical institutes, including 10 of agriculture and 40 of commerce. Prussia has 260 such schools, with over 12,000 pupils; thirty-five of the schools are for painters and decorators, 16 for tailors, 9 for shoemakers, and so on. Every trade has at least one. The royal government appropriates $600,000 a year for their support, besides liberal subsidiaries from towns and cities, Berlin alone paying $70,000 a year. Baden, with only 1,600,000 population, spends $280,000 a year on technical schools. Hesse, with 1,000,000 population, has 83 schools of design, 43 of manufacturing industries and many others for artisans of various trades. Bavaria, Wurtemberg and other states have similar systems. The whole German people are being educated scientifically in the arts of industrial production. No wonder "Made in Germany" is becoming a familiar trade-mark in all the markets of the world.—Kuhlow's.



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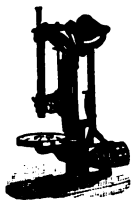

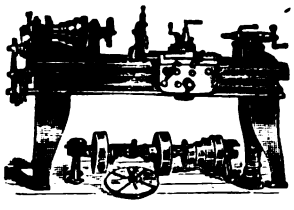

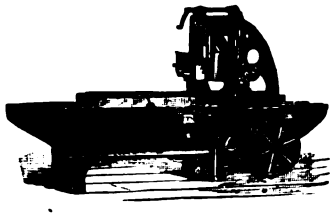

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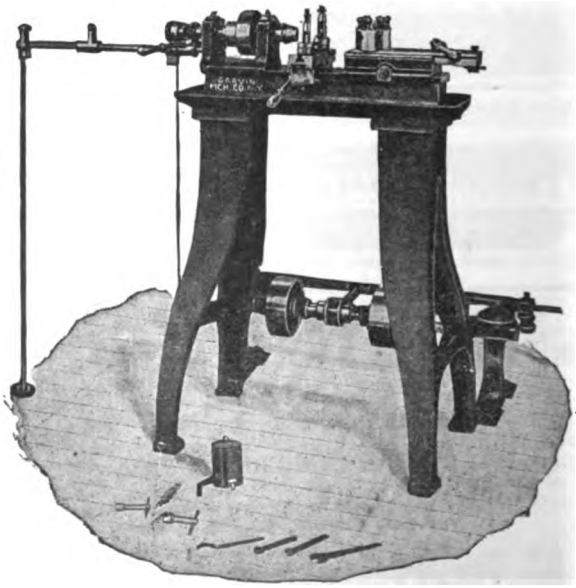

No. 00 SCREW MACHINE (WIRE FEED).

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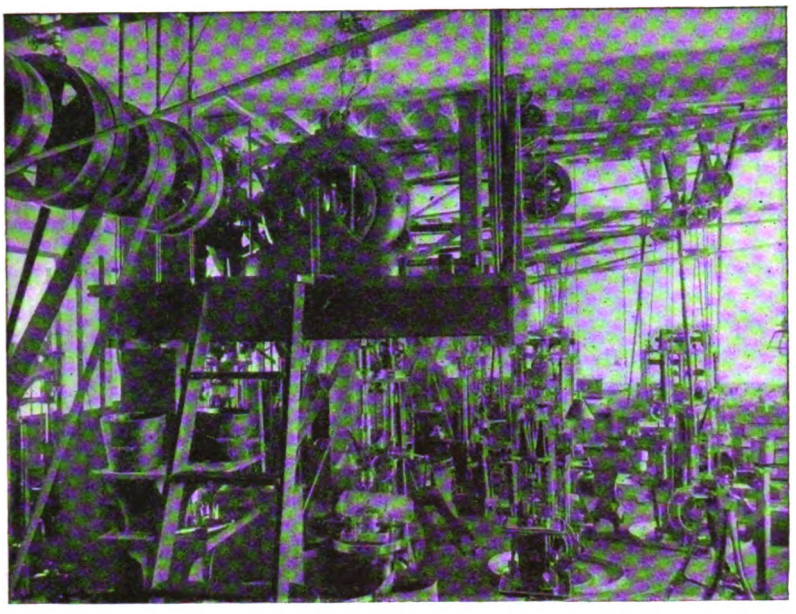
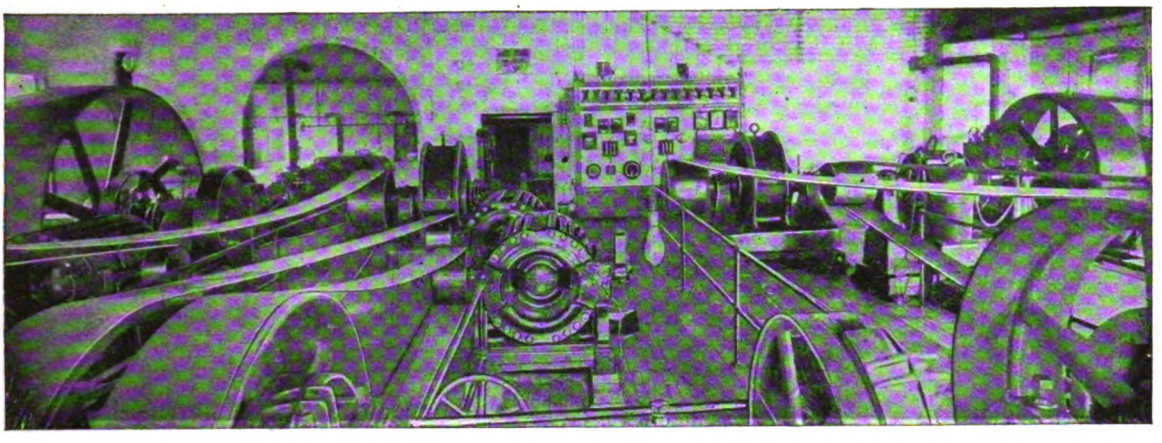
The Electrical Age.

VOL. XXI—NO. 14 NEW YORK, APRIL 2, 1898 WHOLE NO. 568



Drill Room, Miama Cycle & Mfg. Co.



Interior of Station.

MONOCYCLIC STATION AT MIDDLETOWN, O.

The number of central stations using that modification of the single-phase system known as the monocyclic, by which current may be supplied to both lamps and motors at the same time from their alternating generators, has within the past two years greatly increased. This system was introduced at a time when the question of extending their area of operations began to force itself upon the attention of central-station managers using either the single-phase alternating or the direct-current system of supply. With the first-named the question of distance presented no difficulty, but motors could not be operated successfully by it ; with the direct-current system, while the motors presented no difficulty, the area of operation was limited. With the newer system it was found that both arc and incandescent lamps, as well as induction motors, could be supplied from the same alternator, the first-named operating directly from the ordinary two-wire single-phase circuits, the motors merely requiring a third wire to give a displaced voltage. Operation of the monocyclic system has evidently proved satisfactory, as the present installations number not less than ——.

An interesting example of the introduction of the monocyclic system into a direct-current station, allowing the area of its operation to take a wide extension, exists at Middletown, Ohio, where Mr. E. H. McKnight, the President and General Manager of the Middletown Electric Light and Power Company, has recently found it necesary to increase the monocyclic capacity of his plant to meet the increased call upon his station. In addition to the arc and incandescent lighting usual in towns of the size of Middletown, certain factories under progressive managers have adopted electricity in place of steam, and the motor load on the station already far exceeds the lighting load.

The station fronts on the Miami and Erie Canal, having the tracks of the M. and C. Railroad immediately behind it. It is 65 feet wide and 115 feet long. Steam is supplied from two Brownell and Company Dayton boilers, to one 450 H. P. compound condensing Buckeye engine, and one 300 H. P. four-valve Russell condensing engine. The generating plant consists of two General Electric 12-pole, 150-Kilowatt, 1,040-volt, 600-revolution monocyclic generators excited by two 1½ K. W. exciters ; three 50-light Thomson-Houston series arc dynamos, and one G. E. 100 H. P., 500-volt, direct-current generator, all driven from countershafting furnished with the necessary friction clutches.

The 500-volt machine is used exclusively to furnish direct current to several small motor plants throughout the city ; the arc machines operate 112 city arc lamps.

The motor load on the monocyclic machines runs up to

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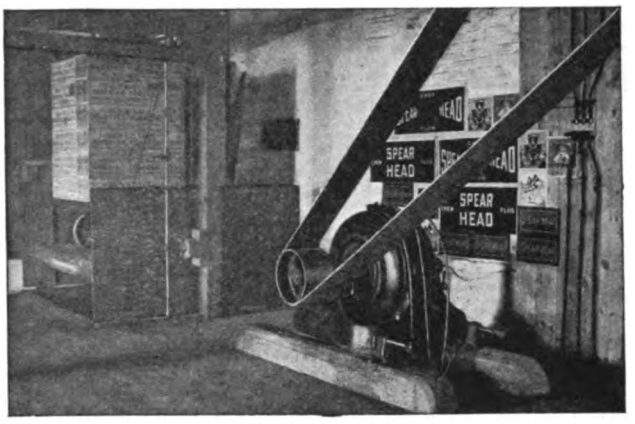
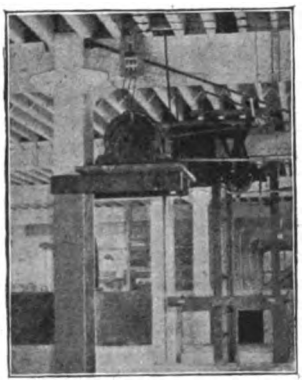
within a short limit of their capacity. The factory of the Miami Cycle and Manufacturing Company, a little over a mile from the station, takes 200 H. P. when its motors are running at their rated capacity, and considerably in excess of this under usual working conditions. This company manufactures the well-known Raycle, and 1,200 of these wheels are built weekly, giving employment to 600 hands. The current is received in the factory in six 40 H. P., one 20 H. P. and two 10 H. P. transformers, reducing the pressure to 115 volts. The motor circuits run from the 40 H. P. transformers, the lighting circuits from the three of smaller capacity, and all the current is measured in a recording watt meter, connected on the primary circuit. The motor equipment consists in all of ten General Electric induction motors—three of 20 H. P. in the machine shop, driving 88 machines ; one of 10 H. P. in the drill and pattern room, driving 29 machines ; another of 10 H. P., driving the machinery in the frame department ; three of 30 H. P. in the polishing room—two for the polishers and one for the 48-inch exhaust fan ; one of 5 H. P., driving two plating dynamos in the plating room, and another of similar capacity operating a number of small machines in the assembling room, as well as a three-ton elevator. The incandescent lights in the factory number 750, of which during the rush season almost all are lighted.

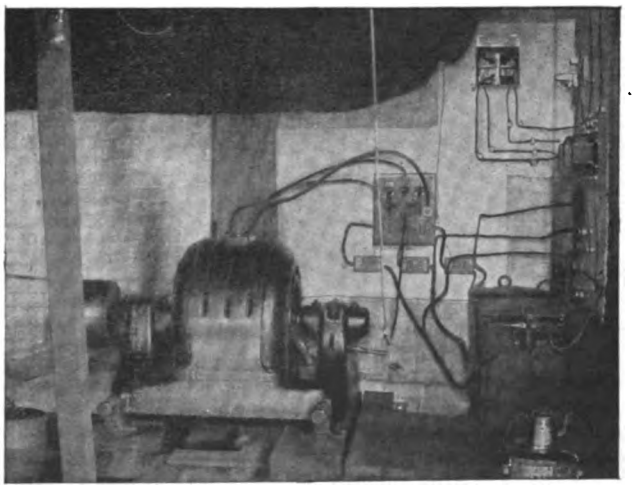


Assembly Room.



Forge Motor No. 1.

In addition to the cycle factory, Mr. McKnight furnishes power to the tobacco factory of the P. J. Sorg Company, in which two departments are already equipped, each with a G. E. 30 H. P. induction motor. The first (Fig. —) is the smoking tobacco department, on the first floor, and is belted to shafting operating, on the three floors above, 3 Caldwell pickers, 1 cutter, 2 granulators and 2 dust machines. The second motor is on the



Motor No. 2 in the Factory of the P. J. Sorg Co.

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sixth floor (Fig. —), and is shown with the transformer and the meter to which the primaries from the station are connected. From this point secondaries are carried to motor No. 1 in the smoking tobacco department, distant about 500 feet, and the lights in the different departments being tapped off before the motor is reached. Motor No. 2 drives two 7½-inch Sturtevant fans, used to dry all the tobacco. It also operates a five-ton elevator. The capacity of the drying department is 100,000 pounds of tobacco daily.

The benefits of electric drive by induction motors are, perhaps, nowhere so forcibly demonstrated as in these two installations. In the cycle factory, the constant speed of the machinery, the absence of vibration and the power of the motors to respond to calls reaching as high as 50 per cent. over their rated capacity, have enabled the manufacturers to give to every part of their wheels a perfect finish, as well as to greatly increase the output. In the tobacco factory, the steady rate at which the tobacco passes through the dryers gives it a uniform cure. Previously, the speed being variable, the tobacco would dry in spots only, and a second handling was almost always necessary. According to the foreman, the motor "saves him lots of time."

The incandescent lights in the town already wired number 3,800 ; of these, 750 are in the cycle factory, 100 are in the tobacco factory, 650 are in the Opera House, and 2,300 in other parts of the town. These lamps burn with absolutely no interference from change in the motor load ; in fact, the entire motor load may be thrown on or off without in the least affecting the burning of the lamps, the presence of the motor load being usually only determined by reference to the ammeter. The monocyclic machines operate with almost perfect regulation, requiring little or no attention to maintain the constant potential at all times.

A syndicate of New York and Saratoga capitalists has purchased, at a cost of $60,000, the land in the vicinity of Hell Gate Rapids, on the upper Hudson, about seven miles above Glens Falls. The intention is to utilize the great water power at the place for an electrical plant. A dam and power house are to be erected, and with the electricity generated therein a railroad, to be known as the Saratoga Northern, running between Saratoga Springs and South Glens Falls, will be operated. This road will have branches to intermediate places and also to Glens Falls, Sandy Hill and Fort Edward.—Scientific Am.

Work on the Jungfrau railway is progressing satisfactorily. The Lauterbrunnen River furnishes 2,400 horse power used for the electric rock drills. The bed of the river has been changed for a distance of about six miles. The line is practically complete to the Eiger glacier, and this section will be opened for traffic in June. Work has also been begun on the main tunnel, and more than 150 yards have been completed ; the solid rock has been found at 30 yards under the snow, instead of 70 yards, as first expected.—Cosmos.

THE DEVELOPMENT OF ELECTRICAL SCIENCE. *

In a brief discourse on the development of electrical science little time can be given to the early history of the subject. This part is more or less familiar to all the members of the Academy, and hence it may be passed over by only such brief reference as may serve to recall to mind the more important of the early discoveries. The early Greeks have recorded some elementary phenomena now known to be electric, and it is probable that such knowledge was not uncommon, though little noticed. It is only in comparatively recent times that scientific research has taken the place of superstition and attempts have been made to classify and find reasons for the existence of all natural phenomena.

Beginning with the 17th century, probably the first investigator worthy of notice in this subject was Gilbert, of Colchester, who published his work entitled "De Magnete" in 1600. Gilbert made systematic experiments and showed that the property of attracting light bodies could be given to a large number of substances by friction. He also showed that the success of the experiment depended largely upon the dryness of the body. These experiments gave rise to the classification of substances as electrics and non-electrics. The true significance of Gilbert's observations as to the effect of moisture was not appreciated for a long time. Gilbert's list of electrics was added to by a number of other observers, prominent among whom were Boyle and Newton. The fact that light and sound accompany electric excitation was called attention to by Otto von Guericke, who also showed that a light body, after being brought into contact with an electrified body, was repelled by it.

Coming now to the 18th century, we find Hawksbee in 1707 and Wall in 1708 speculating on the similarity of the electric spark and lightning. Then comes one of the most prominent experimenters of this century—Stephen Gray—who began to publish in 1720, and who in 1729 found that certain substances would not convey the charge of an electrified body to a distance. These experiments were the first to introduce the distinction between conductors and non-conductors, and, of course, very soon served to explain the reason why certain substances could not be electrified by friction when held in the hand. Gray also made the important discovery that the charge of an electrified body is proportional to its surface, and this was afterwards confirmed by the experiments of Le Monnier. Many of Gray's experiments were repeated and extended by Du Fay, who found that all bodies could be electrified by friction if they were held by an insulatory substance. Then came the improvements of the electric machine by Boze and Winckler ; the firing of inflammatory substances, such as alcohol, by means of the electric spark by Ludolph, Gordon, Miles, Franklin and others. About this time (1745) the properties of the Leyden jar were discovered by Kleist, Cuneus and Muschenbroeck, and a few years later it was given practically its present form by Sir William Watson. Then follows one of the periods of exceptional activity in electrical research. A party of the Royal Society, with Watson as chief operator, made a series of experiments having for their object the determination of the distance to which electrical excitation could be conveyed and the time it takes in transit. They found among other things that several persons at a distance apart might feel the electric shock if they formed part of a circuit between the electrified body and a conductor such as the earth ; also that the earth could be used to complete the circuit in Leyden jar discharges. They concluded that when two observers, connected by a conductor, and at, say, two miles apart, obtained a shock by one touching the inside coating of a Leyden jar and the other the earth, the electric circuit was four miles long, that is, the earth acted as a return conductor. They also concluded that the transmission was practically instantaneous. Watson had ideas as to electric fluids similar to those which were afterwards systematically worked out by Franklin. A great many curious and interesting experiments were made about this time, as, for example, the influence of electrification on the flow of water through capillary tubes as discovered by Boyle, the experiments of Mowbray on the effect of electrification on vegetation, and those of the Abbe Menon on the loss of weight of animals when they were kept electrified for a considerable time.—Science.

[To be Continued.]

* Address of the President, Professor Thomas Gray, delivered before the annual meeting of the Indiana Academy of Sciences on December 29th, 1897.

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INSULATION AND CONDUCTION. *

BY REGINALD A. FESSENDEN.

A thing insulates because it is possessed of two distinct properties, first, the ability to stand the mechanical and electrical stresses due to the voltages used ; and, secondly, because it is such a poor conductor that but a negligible small current can flow through it and leak away. In other words, it will neither allow the current to break through it, nor to steal through it. The first property is called by Maxwell the "dielectric strength" of the insulator, the other property is called the ohmic resistance. The two together form its insulating power.

In the two great branches of electrical work, the requirements for an insulator are widely different. For apparatus used for the transmission of intelligence, as a rule low voltages are used, and so dielectric strength is of relatively small importance ; but the currents used are small, the circuits long, and material of high ohmic resistance is needed. For apparatus designed for the generation and transmission of electric energy, on the other hand, where the voltages are high and the currents large, dielectric strength is the main thing desired, and the leakage of a small amount of current is not objectionable. Consequently the two branches of the profession have come to use the word "insulation" in quite different senses, the former and older as meaning something having high ohmic resistance, and the latter branch using it with reference chiefly to material having great dielectric strength.

Confusion sometimes occurs through this double meaning, and the writer himself has been taken to task by a European engineer for stating that pure water was approximately as good an insulator as rubber, the critic having reference, as was apparent, to its ohmic resistance, whilst the original note was principally concerned with its dielectric strength. It is therefore considered best to define the sense in which the word is used, in spite of the fact that attention has previously been called to the distinction to be made between these two properties ; notably and very lucidly by Mr. Steinmetz in this Institute's proceedings, vol. ix., p. 815.

Before entering upon the discussion of the various purposes for which insulation is used and of the substances best suited to each case it may be as well to give a brief account of the manner in which the current passes through materials.

1. By actual connection.—That is by particles of the insulator, or of foreign substances, taking a charge from one electrode and moving with it to the other terminal under the influence of the voltage. This action is similar to that of the moving pith ball between the two knobs of a Holtz machine.

This phenomenon is not known to take place in solids, but it is quite marked in gases, vapors and fluids.

Until recently it was a question of no practical importance in electrical engineering, but with the high voltages now in use or contemplated it may give serious trouble, and apparatus must be designed to check this form of leakage. It was not so long ago that Ferranti's 10,000 volts was looked upon as monstrous, but some experiments of the large companies, of which I have been informed, seem to show that 100,000 volts may be quite practicable, even in quite unfavorable climates. With overhead wire the leakage will merely mean a loss of energy, and the use of porcelain for all insulation, as any oxidizible material (used for instance to protect the primaries of transformers), would be speedily destroyed by the ozone. Where, however, oil is used in the transformers, the leakage may cause quite serious trouble, owing to the large surfaces and their proximity. In addition, as Prof. Elihu Thomson pointed out some years ago, with high potentials, impurities in the oil are apt to group themselves along the lines of highest slope of potential like the iron filings around a magnet, and if, as is generally the case, the impurities have a higher specific inductive capacity than the oil such a group is thus apt to form a bridge between two points of great difference in potential, hence causing an arc. In those convection currents it is not, I believe, the very small particles which cause the trouble, because small bodies, when charged from a comparatively large and smooth one, are not repelled but attracted ; consequently a small grain of dust after touching a highly charged flat conductor would remain close to it if there were no negatively charged particles near it to drag it away or no currents in the oil to wash it off.

The relation between the size of the particle, the voltage, and the radius of the charged conductor when the particle after touching the conductor is neither attracted nor repelled can be obtained by the method of images,

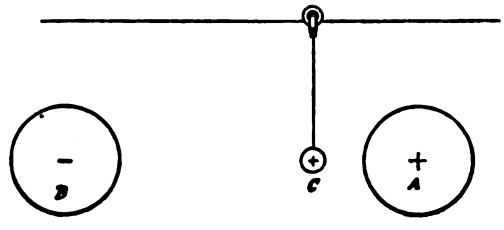

Fig. 1.

The Ball, C, having touched A and got A+ charge, is repelled and moves over to B, where it gives up its charge, takes up A— charge and moves back to A.

but the formula so derived is rather long and complicated and I have not had time to work out the numerical results.

It is evident, however, from it, that for a convective current to take place the radius of the particles carrying the discharge must be a quite appreciable fraction of the radius of the charged conductor. Consequently this form of leakage is due to the motion of a portion of the oil as a whole and not of its individual particles, and if we can break up mechanically these currents we can to a great extent stop the leakage from this cause. This may be done in three ways :

1. By using oil of great viscosity, in which case, however, we lose the chief advantage of oil insulation, i. e., its ability to re-insulate quickly after a discharge.

2. By putting pure dry cellulose in some form or other between the charged surfaces loosely, so that the oil can filter through it easily and any air escape readily, but sufficiently close to prevent any rapid flow. Pure cellulose has the great advantage that when well boiled in the oil it has approximately the same specific conductive capacity as the oil. No varnish or shellac should be used in the oil for reasons given later.

3. By dissolving a solid, non-disassociating substance in the oil in such excess that it crystallizes out at ordinary temperatures and forms with the oil a soft, gelatinous mass, not fluid, but yet capable of allowing the oil to ooze through its substance. This has many of the disadvantages of 1, but it has one advantage, in that the substance chosen may be one, like paraffin, having a large specific heat of liquefaction, and consequently an overload

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will not raise the temperature of the oil above a fixed point till the paraffin is all melted.

The effect of points in promoting convective discharges in air is well known. It is usually attributed to the great surface density of electricity which a point must take in order to make the potential all over the conductor the same, and hence, since the repulsive force varies as the square of its surface density, it is evident that there will be a great tendency for discharge from a point from this cause. But there is another and very important one, i. e., the fact that, as mentioned above, a particle cannot take a charge and move away unless its radius is larger than a certain fraction of the radius of the curvature of the conductor at the point where it touches the conductor; consequently when the charged surface is a plane only large aggregations of atoms can move away; these move slowly and carry small charges in proportion to their mass. But at points where the radius of curvature is very small, small particles can move away with great rapidity and with relatively large charges. Rounding off or flattening the charged surfaces thus acts in a double way, by reducing the surface density and by preventing all but large-sized particles moving away.

2. Conduction in solids.—It is not absolutely certain that all conduction is not by convection, but the terms are here used with their usual signification. In solids we do not know as yet exactly how the discharge is handed on, but I have noticed a very remarkable fact, which is quite significant and suggestive, i. e., that the conductivities of metals are proportional to the quantity

$\sqrt{\frac{\text{elasticity}}{\text{density}}} \div$ valency. The following table shows this.

This fact was discovered by the writer in 1892,* as the result of several years' tedious work in collecting physical data and combining them into formulæ to see if any law could be found. Out of the hundreds of combinations tried, this and another one (really the same ultimately, but expressed in terms of other properties), were the only ones which seemed hopeful. It was stated in the article referred to that this formula could not be quite correct. This was for the following reason: Silver, gold and aluminium should, as will be seen from the formula given below, have resistances proportional to the square roots of their densities multiplied by their valencies, i. e., in the ratio of

$$\sqrt{10.6} : \sqrt{19.26} : \sqrt{2.65} \times 3$$

i. e., 100 : 136 : 150.

Now at this time the determinations of the resistance of aluminium with which I was acquainted gave it as 193 to silver 100. With such a wide discrepancy therefore between calculation and observation, i. e., 193 instead of 150, it did not seem probable that the high observed value could be modified by subsequent determinations so as to agree with the calculated one. It was, therefore, with considerable pleasure that I saw the recent determination of Messrs. Richards and Thomson (published last year in the Journal of the Franklin Institute). Their results for aluminium, 99.66 pure, were:

Aluminium : Silver : : 163 100,

and they expressed the opinion that the value for pure aluminium, when hard-drawn, would be 66 per cent. of the conductivity of copper. This result is so close to the calculated result given in the paper referred to, i. e.,

17 : 27 = 100 : 159,

though such a high conductivity for aluminium was considered beyond the bounds of probability at that time, that I feel justified in considering that the formula given may be found fairly accurate when more exact determinations shall have been made.

This formula throws a certain light on the nature of conductivity in solids, and why some solids are insulators. For the formula $\sqrt{\frac{\text{elasticity}}{\text{density}}}$ is the same as that for the velocity of sound in a body. Now, in the convective discharge, the electricity was handed on with the same velocity as that with which the particles moved. In fluids, as we shall see, the electricity is handed on with the velocity with which the ions move. In both cases the electricity travels along on the particles of matter.

[To be Continued.]

* A paper presented at the 123rd Meeting of the American Institute of Electrical Engineers, New York, March 23rd, 1898.

* Science, July 22, 1892.

COILS FOR HIGH-TENSION DISCHARGES.

Beside the many difficulties experienced in insulating coils used for high-tension discharges, I have found that one of the most serious is due to the making of splices within the coil itself; it having been my experience with soldered splices that the chances of leakage and a disruptive discharge between the layers are greatly increased, even though the soldered splice is carefully insulated with more than the usual amount of insulating material. In a coil recently constructed by me which operated in oil and consisted of 15,000 convolutions of No. 34 wire insulated with four layers of silk, the difficulty above described was met with and ultimately caused the total destruction of the coil, which represented labor of at least one week. I mention this for the sake of those that are interested in the construction of secondaries for high-potential discharges and would suggest that in place of the ordinary soldered joint they effect a union between two pieces of wire outside of the coil and leave the extremities thus joined external to it and immersed in oil with the coil itself. It has been my experience with a coil operating with the splices inside that a six-inch spark could only be produced, whereas I found that with such splices made as above described the sparking capacity of the coil increased to ten or twelve inches. In vacuum-tube lighting, involving the use of coils carrying very high potentials, insurmountable difficulties will present themselves unless this matter of insulation and splicing be carefully attended to. It is very likely that the ordinary spark coil for X-ray work would be greatly increased in capacity if the secondary were immersed in oil and its splices made and kept external to the coil.

Yours truly,
John W. Haines.

NEW YORK ELECTRICAL SOCIETY.

186TH MEETING.

The 186th meeting of the Society was held at the College of the City of New York, Lexington avenue and 23d street, on Wednesday, March 30th, at eight p. m.

Mr. Frank E. Knight read a paper on "The Influence of Electric Railroads on Population and Land Values in Cities."

After this paper, Mr. J. W. Clarke gave a practical demonstration of the Marconi System of Wireless Telegraphy by means of an improved apparatus.

On behalf of Mr. John Dennis, Jr., the inventor of the Fluorometer, Mr. Clarke also described the operation of that instrument as a surgical adjunct of the X ray.

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THOMAS A. EDISON, JR.

Mr. Thomas A. Edison, Jr.,
96 Broadway, New York City.

Dear Sir:—The sample package of "Edison, Jr., Improved Lamps" was received in A1 condition. Thanks. Have put fourteen of them on and they give a fine white light.

I am well satisfied that the Edison, Jr., Improved Lamp is superior to any lamp which I have used, and I have used over thirty different varieties.

I have one of your lamps which I have had for some time, which is a good recommend. It is a 100-volt, 3-watt, 16 C. P. lamp. When I first purchased the lamp I placed it on a 104-volt circuit alternating current, and by photometric test it emitted a light of over 21 C. P., almost 22 C. P., when compared with lamps that other manufacturers send out and call 16 C. P.

I kept this lamp in circuit for just 600 hours. The voltage has run from 101 to 106, but had been kept at about 104 1-2 by a recording voltmeter. At the end of the 600 hours the lamp was tested for C. P. A light of nearly 19 1-2 C. P. was the result, operating at an efficiency of approximately 2.5 watts. Now, I have tested many a lamp, and never has a lamp shown up as well as this one, although once in a while I get hold of an exceptionally good lamp better than the average run.

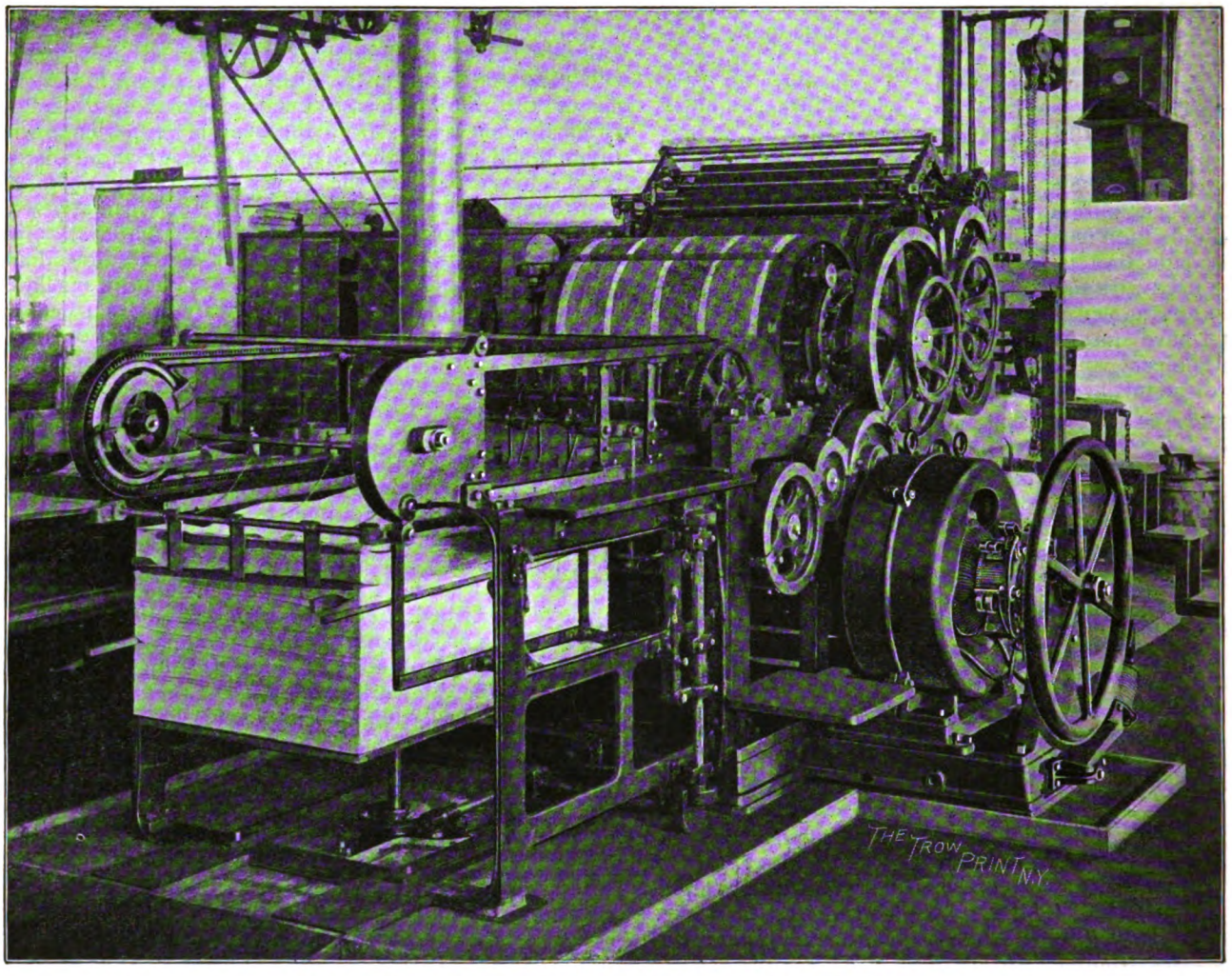
The lamps you sent me show off in great style when burned at normal voltage.

I shall order more of your lamps soon and shall use the Edison, Jr., Improved Lamps on all systems which I wire hereafter. Yours faithfully,

(Signed) Leverett M. Clark,
Electrical Contractor.

PRINTING BY ELECTRICITY.

The printer has had a great deal to contend with in the last decade. Since the art of printing has so developed that it may really and truly be called an art, printers have realized that they belong to a higher and better class of workers than they at first supposed. The printer of to-day must reproduce photographic engravings with an accuracy that is truly wonderful. He uses lithographic stones in producing remarkable color combinations, and he has learned to become an expert in judgment on the various grades of paper employed by him for letter printing, color printing and half-tone work. His trade has become divided up into many departments, and it is almost impossible to conceive of anything more difficult than a close practical study of them all.



Cottrell No. 7 Rotary Perfecting Press with 7½ H.-P. Motor,

One of the great troubles that printers owning their own plant have met with is the irregularity of their power supply or the lack of it when most needed. An observer wandering through printing establishments of moderate size will find that proprietors frequently install gas engines, motors, and, in one case that came under the writer's notice, a vertical engine and boiler on the very floor where the printing was done.

The demands of printers and the requirements of the printing shop have been carefully studied by the Sprague Electric Company, 20 Broad street, New York City. Having long realized that the printers in moderately good circumstances would certainly like to do away with the trouble experienced in handling gas engines, etc., they have manufactured motors specially adapted to the sudden strains experienced when heavy pressures are thrown on. In addition, considering the proprietors of great printing establishments not fully equipped with

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The Electrical Age.

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NEW YORK, APRIL 2, 1898.

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ELECTRO-MAGNETIC WAVES.

An article with a title of this description is one which the public regard with averted eyes. Few of them know what electro-magnetism is, and fewer still that at all comprehend the meaning of the expression, electro-magnetic waves. It is strange to realize how quickly they fall in line, however, when occasion demands, and grasp the meaning of a phrase which may seem to belong to the scientific and complex. We are now on the eve of a momentous change—a study of the invisible, as some enthusiasts choose to call it, has become an important branch of engineering and threatens to exercise a widespread influence over great fields of work. Prof. Hertz has written a treatise on electric waves, which has been supplemented and commented upon by Profs. L dge, Jones and others. So far as we have gone, practical men have concluded that the only solution to the problem of economical lighting and telegraphing through space without wires is to be found in the use and proper manipulation of electric waves. Why should not future methods of transmitting power rise superior to the necessity of using wires, when the latest investigations show and prove that electrical energy is really transmitted, not within the wire, but external, in the form of electro-magnetic disturbances of a systematic nature? It is not alone the interesting field of electric signalling that will be considered by those who interest themselves in this department of work, but other great problems of tremendous scope and immediate usefulness; in fact, it seems as though a new era were about to open up in the broad and comprehensive field of electrical engineering, one in which this mysterious force of nature will be guided along great paths of unlimited extent with but little retardation or loss. The apparatus at present in vogue for producing electro-magnetic waves consists of spark coils, condensers and other devices creating high potential discharges, such as a combination of transformers, etc. Although so far these waves have merely been produced for experimental purposes and have served the purpose of actuating a distant relay or its equivalent, no attempts have been made to transmit any considerable amount of power by such a system. When ordinary Leyden jars throw out oscillations they are at least one hundred and fifty feet in length. Dr. Hertz invented an oscillator which merely consisted of two brass knobs placed at the terminals of a secondary coil. The capacity of the brass spheres affected the nature of the waves radiated into space. Prof. Lodge has also invented an oscillator similar to the one invented by Hertz, with the difference that the discharge between the two brass knobs passes into an intermediate and larger sphere. By means of this arrangement, waves less than an inch in length were produced. Finally, Marconi used an oscillator well known to the reader of electrical literature. Two large brass spheres plugging up the ends of a cylinder containing oil, and two smaller spheres, from which the discharge passes into the larger two, constitutes the invention of Marconi. Rose, another experimentalist, devised an outfit for producing electrical oscillations which is practically applicable to wireless telegraphy. The receiving device known by the name coherer is of simple construction, and performs its function by merely responding to the influence of electric waves and thereby setting into operation another circuit carrying a powerful current. Waves of this description, though produced in greater number, are used in vacuum-tube lighting, and the success of electric signalling without wires and a system of tube lighting depend upon the number and frequency of these electro-magnetic disturbances. It is the opinion of our most eminent scientists that light is an electro-magnetic phenomenon, and it seems certain that a closer acquaintance with the manner in which it is produced will develop this latest field of investigation, which deals exclusively with the nature and character of electro-magnetic waves.

OBITUARY—NELSON W. PERRY.

Nelson W. Perry, aged fifty-two years, a well-known writer on electrical science, died at his boarding-house, 17 Sidney place, Brooklyn.

On March 26 he experimented all day with an incandescent burner. He had attached the apparatus to the only gas jet in the apartment, and found it necessary to turn off the gas at intervals.

On a table nearby were two glasses, one containing drinking water, and the other the bichromate of potassium. At a time when the room was dark he picked up what he thought was the glass of water and drank it. Immediately he called for help.

Dr. J. E. Truslow, of 186 Clinton street, administered antidotes, but Sunday evening the patient died.

The sick man's wife had been in Johns-Hopkins Hospital, Baltimore, where she was recovering from a surgical operation. She was able to come to the bedside of her dying husband.

The deceased was a native of Ohio. He had lived in Brooklyn for four years. He leaves a widow and three children. His father is a justice of the Supreme Court of Ohio.—N. Y. Journal.

In the article on insulation and conduction by Reginald A. Fessenden, a clear explanation is given and distinction drawn between the meaning of "dielectric strength" and what is regarded as its synonym, ohmic resistance. Mr. Fessenden implies that dielectric strength is a measure of the ability of an insulator to stand the mechanical and electrical stresses due to the voltages used, but the ohmic resistance relates to the character of the insulator, as a conductor, through which a current will pass of negligible quantity or with great volume. In other words, the dielectric property of an insulator differs entirely from its ohmic resistance.

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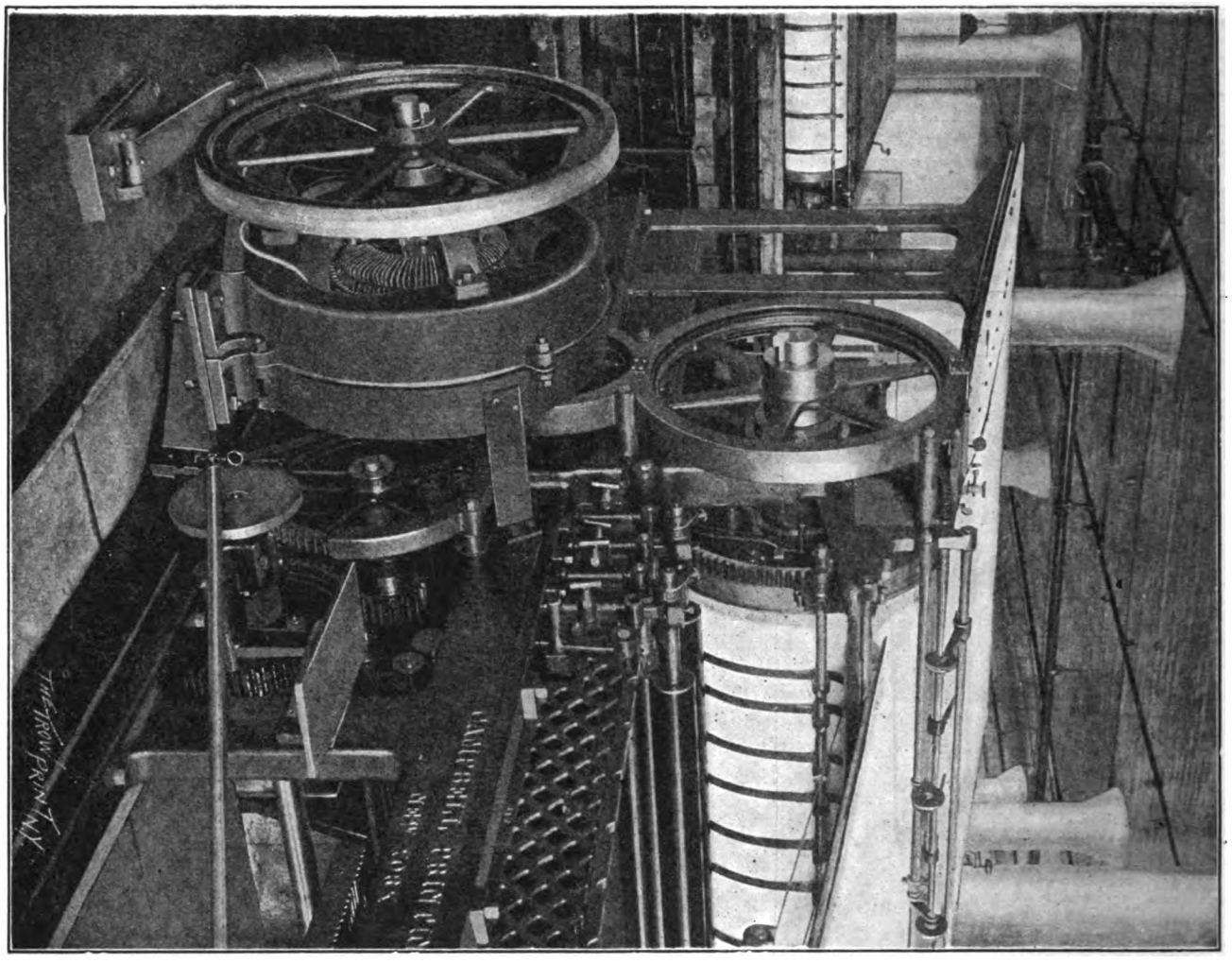
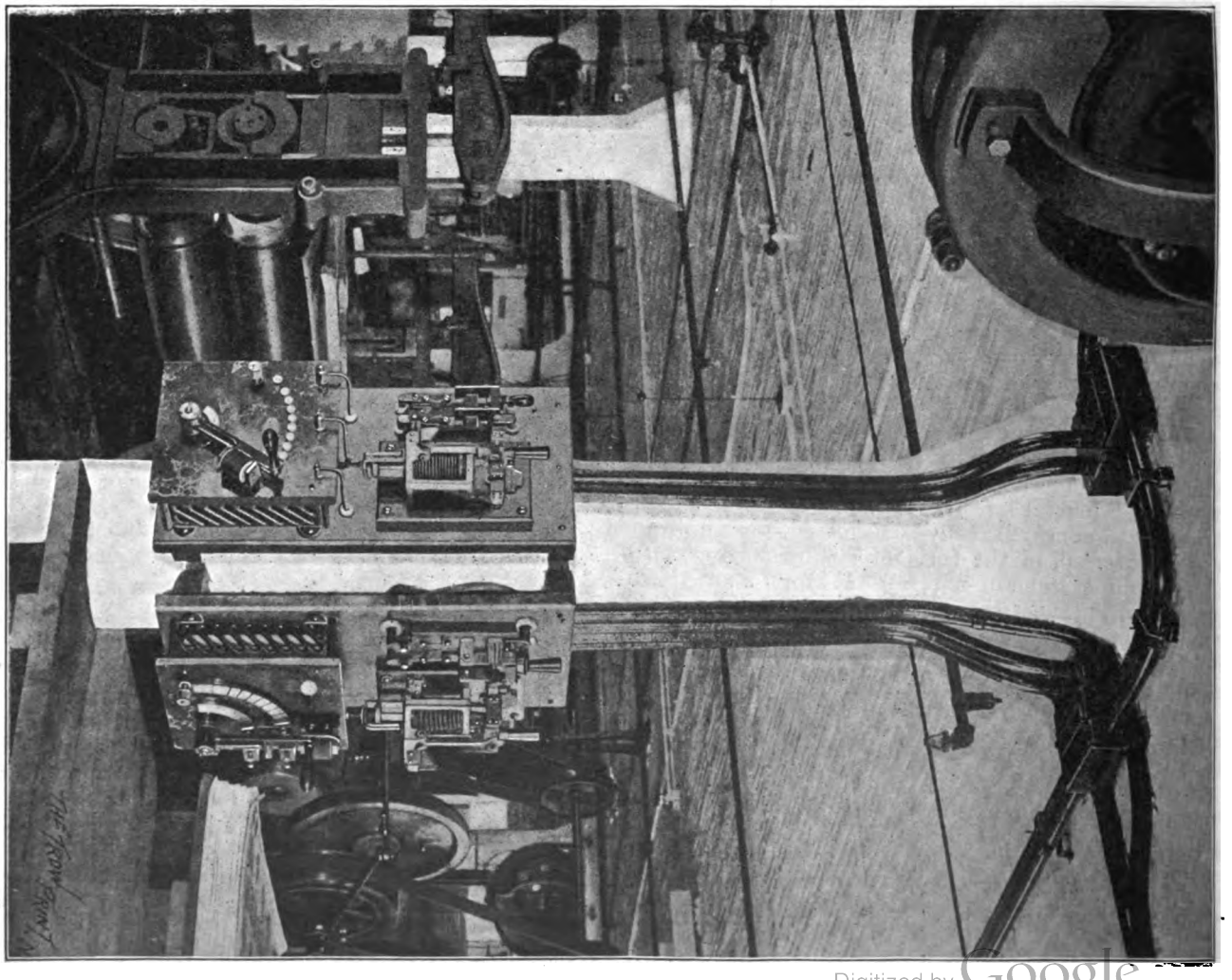


Campbell No. 00 Century Two-Rev., 5 H.-P. Motor.



Shows Method of Control for Ceiling Motors.

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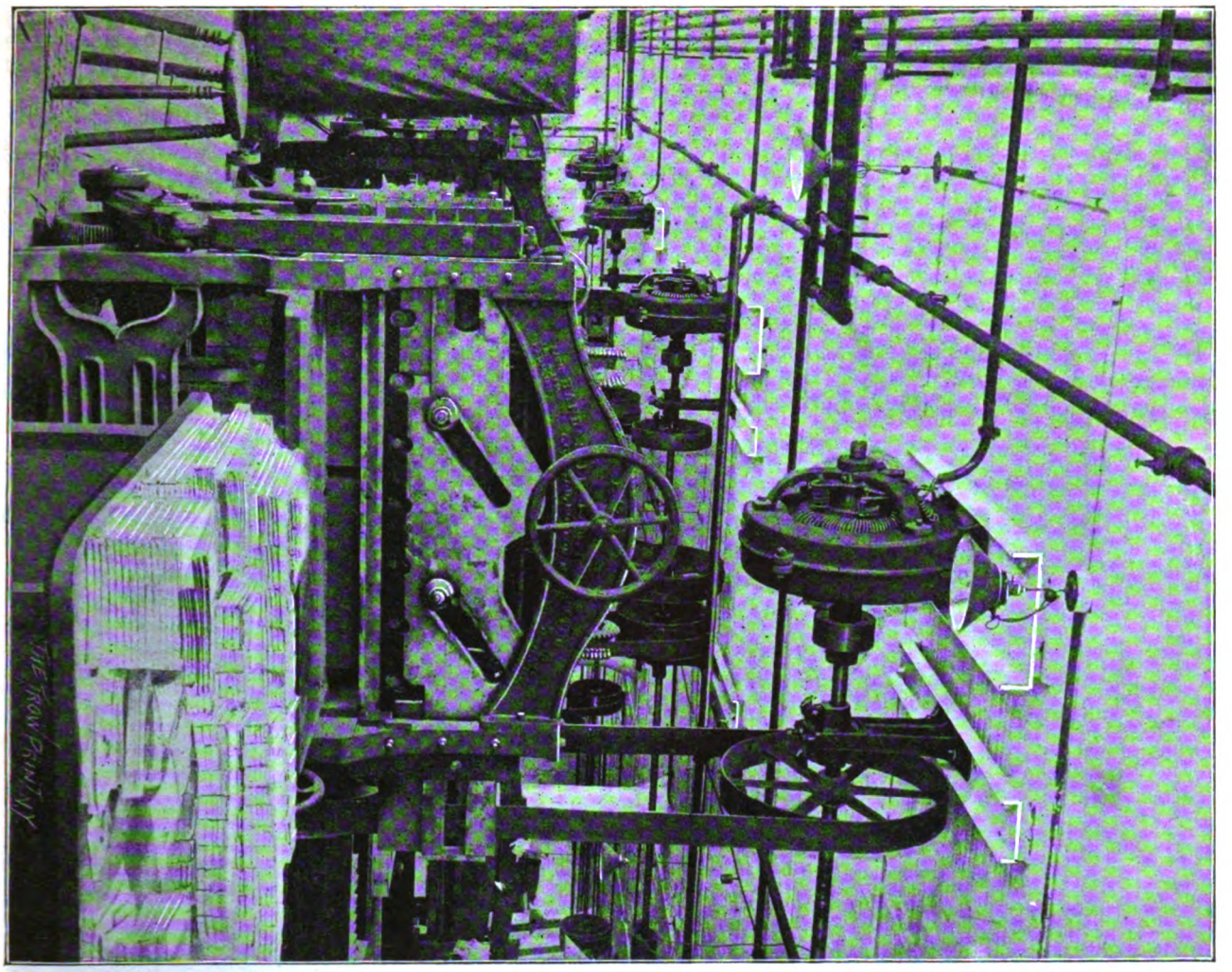
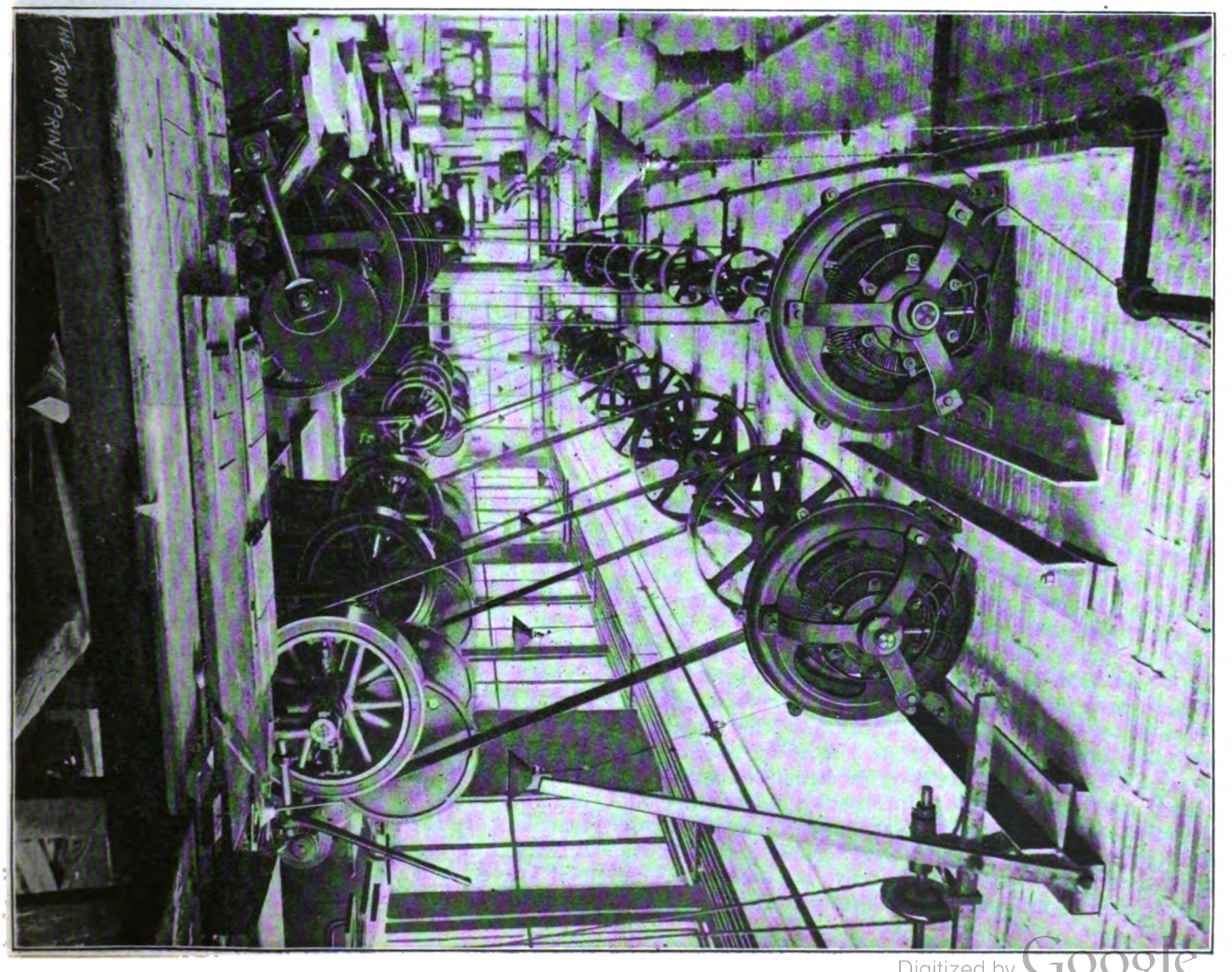


Line Shaft Motors Driving Paper-Cutting Machine.



Line Shaft Motors Driving Embossing Presses.

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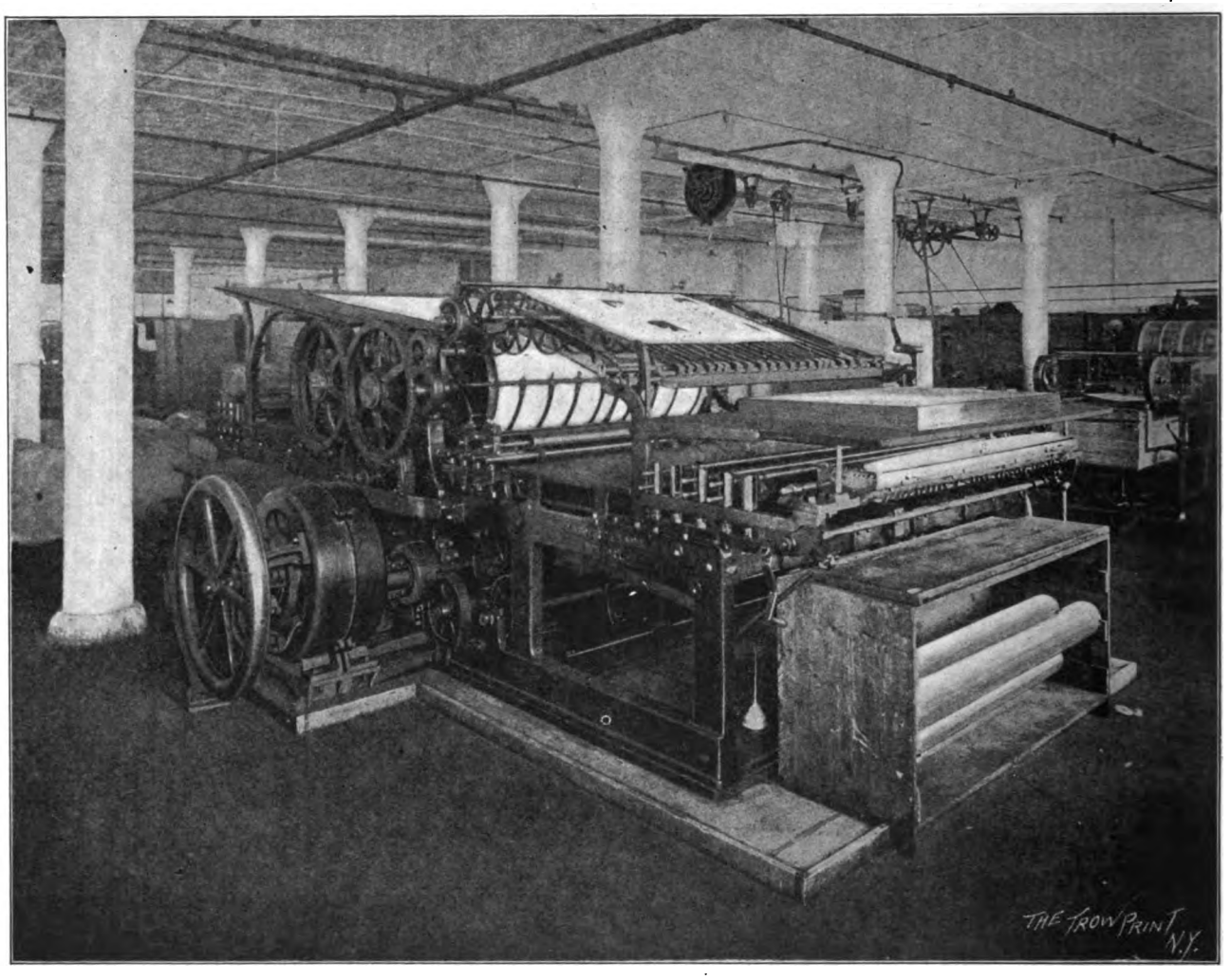
all power proceeding from one or two large motors, they have designed and manufactured special motors which are directly connected to each large press and exercise individual control over it.

In the illustrations shown in connection with this article motors direct-connected to very large presses employed in well-known establishments indicate the practicability of this scheme. The titles are given beneath each illustration, and we can only say that the proprietors have in every case expressed their utmost satisfaction at the celerity with which work is done and ease of control experienced by the operator.

The Sprague Electric Company also manufactures line-shaft motors, which, as seen, may be attached to the ceiling, operating a line of shafting and driving with ease and economy embossing presses or other machinery placed below. Another illustration gives the reader an idea of the method of controlling line-shaft motors or ceiling motors, the automatic cut-out switch and starting-box connecting with each one being placed in a position immediately accessible to those in charge.

When it is realized that the loss in a building from cellar to top floor due to the line of shafting intervening may amount to forty per cent. of the power supplied, the absence of intermediate contrivances and the benefit of directly applying the power where it is to be used makes the use of ceiling motors or motors direct-connected to machines a problem not only interesting technically but financially. The conservative statement may be made that fifty per cent. of the power generated in New York City and transmitted mechanically is wasted. This would represent millions of dollars per annum, yet it seems strange to realize that those apt to be most benefited by the introduction of these devices are often the slowest to adopt them.

The above illustrations have been taken from plants in actual operation, the electrical apparatus being supplied by the above company, and have from the standpoint of efficiency saved the installees thousands of dollars in time, money and convenience.



No. 10 Cottrell Flat Bed Perfecting Press, 10 H.-P. Motor.

LITERARY NOTES.

There is a good deal of patriotic interest in the April Home Magazine (Binghamton, N. Y.), just out. It is a special naval number, with a number of elaborately illustrated articles, among them one of keenest interest just now on a new submarine boat, never before described. Then there is "The Building of the Ship," in which many points of naval interest are discussed in a way that will interest any one. "In the Harbor of Fayal" is a story of a gallant sea-fight in the war of 1812. Other illustrated articles are "The Strategic Importance of the Nicaragua Canal," and some interesting facts about "Historical Tobacco Pipes." Henry Chadwick has a timely baseball story entitled "A Chapter of Baseball History." There are short stories in profusion and some poetry—in fact there is something to interest everybody, especially people who travel. Of particular interest to the commercial travelers are the news departments devoted to their interests, wherein is contained an account of the Commercial Travelers' Fair held in New York the first week in March, which unfortunately was not a financial success.

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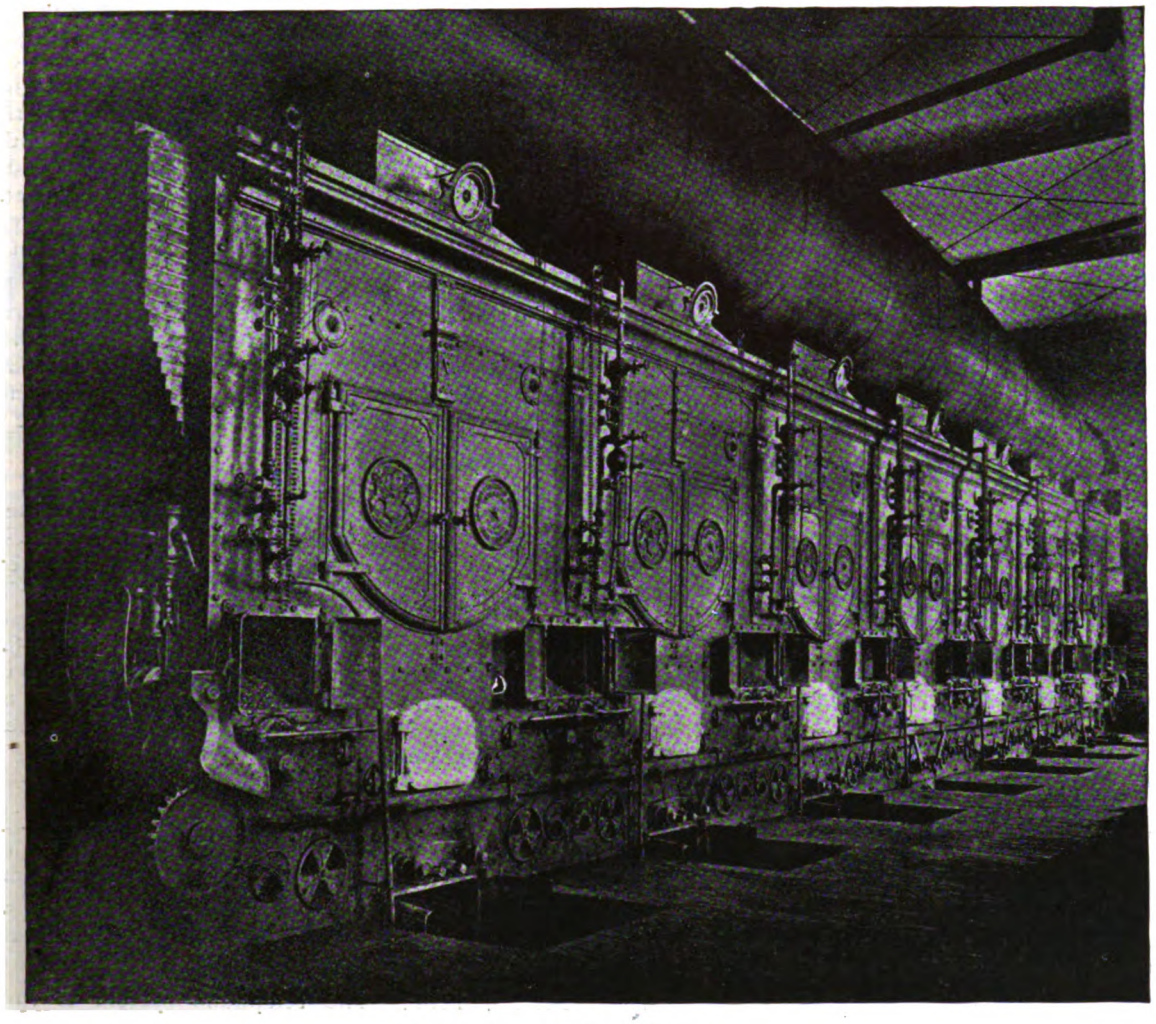
WIRING FOR LIGHT AND POWER.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

The generation, transmission and distribution of power are problems that have occupied the attention and called upon the skill of engineers from time immemorial. There is every evidence to prove that some of the attempts made in early days were none the less worthy of the name of transmission plants than those of modern times—elaborate with improvements and bristling with devices for the safe transference of power.



Boiler Room of Central Station.

The transmission of power is merely the name for a system by means of which energy may be transferred from point to point conveniently and without much loss. Ultimately the power transmitted assumes the form of mechanical energy and is therefore to be looked upon as the result which, by its value in foot pounds, determines the superiority of one system over another. To speak of lighting and power circuits is simply to reconsider the conditions which, in a milder form, are met with when power is to be transferred. The generation of power may be carried on with alternating or continuous currents, but its transmission is not a problem of the same ease of solution.

Alternating Current Circuits.—The peculiarities of an alternating current manifest themselves very quickly under certain conditions. An alternating current is different from the continuous in one striking respect. It oscillates in commercial circuits at the rate of perhaps 100 times a second back and forth. Therefore if any retarding effect ensues it is likely to become highly developed and possibly so affect the line as to render ready transmission a matter of considerable difficulty. The distribution of power by alternating currents gives rise to certain other features of considerable interest to the reader. When power is ordinarily distributed we are not apt to consider the source of power, but merely the fact that it is to be sent from house to house as required.

When power comes from a long distance, the pressure generally is very much higher than it would be were it simply generated in the centre of a very large city. The processes of transformation are more numerous in such a case than would be expected. The Ferranti system in London puts the current through two processes—

Generation at 10,000 volts.

(1) Transformation to 2,000 volts.)
(2) Retransformation to 50 or 100 volts.

It is but necessary to understand that these changes only occur on account of the peculiar system in use, and not because the alternating current must be transformed.

In transmitting power by continuous current the same kind of apparatus is used throughout. To reduce an alternating current either up or down requires the use of transformers. A continuous current can only be changed in pressure by means of motor transformers or storage batteries. To distribute either alternating or continuous current we are forced to use two entirely different systems. They bear a certain relationship, due to the fact that both are for the distribution of electricity, but in technical features they are entirely dissimilar. Power from either continuous or alternating currents means the use of special circuits, special motor and special precautions.

Continuous-current circuits do not show other than the

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most common features of distribution. A generating plant either employs dynamos for the distribution of light, or of both power and light.

(To be continued.)

NEW YORK NOTES.

Anti-Trust Incandescent Lamp Co. have opened an office at 15 Cortlandt street, room 52, for the sale of their lamps in this market. They are made in all voltages and candle-power, and are fully guaranteed to meet all the requirements of a first-class lamp. Write for prices and oblige the Electrical Age.

Elmer P. Morris has removed his offices to Rooms 50, 51, 52, No. 15 Cortlandt street, where buyers of railway, electric light, power, and all kinds of electrical supplies will find it to their advantage to call and leave their orders.

C. W. Hunt Co., 45 Broadway, N. Y., manufacturers of electrical and mechanical coal, elevating and distributing systems, have been awarded some big contracts by the U. S. Government for the War Department at Key West and Dry Tortugas.

Mr. F. Fleck, formerly foreman for Freedman, Rennard & Co., has succeeded to their business at 136 Liberty street, city.

E. J. Fenton, representing the National Conduit and Cable Co. of N. Y., has just returned from an extended trip West and South. He reports a very good outlook for an active spring business.

ELECTRIC RAILROADS IN SEOUL.

I have the honor to inform you that a company has been formed in the city of Seoul for lighting the streets and residences with electricity and for operating electric street railroads through the principal thoroughfares. Only the latter will be begun at once.

The company, known as the Seoul Electric Company, is composed entirely of Koreans, with the governor of the city as president. They have an exclusive franchise from the Department of Public Works, Agriculture and Commerce, and have paid in about one-half of the capital of $300,000.

This company has made a contract with Mr. H. Collbrann, of Denver, the American contractor for the construction of the Seoul-Chemulpo Railroad, for the construction and equipment of an electric trolley street railroad of the latest and most improved design. The railroad will be about six miles in length, and will run from the station of the Seoul-Chemulpo Railroad through the south gate of the city, along the broad streets, past the new palace and foreign quarter, through the busiest part of the city and the great east gate, to the Tomb of the Empress.

Mr. Collbran has received a cash payment of $100,000 with his contract, and the work will be rapidly prosecuted.

It is regarded as a profitable enterprise, since, with a city of 300,000 people and no amusements, there will probably be enough passenger traffic from curiosity seekers to make it pay for a year so, while the people are being educated to the point of regarding the road as a necessity.

At present all the financial ventures of importance in Korea are in the hands of Americans.

Horace N. Allen,
Seoul, February 15, 1898. Consul-General.

Charleston, W. Va.—The Wilson Spring & Telephone Co. has been incorporated by Jos. T. Stubbs, Vernon M. Pierce, Prentice H. Manning, Josiah Hinckley and George G. Hackett. Capital stock, $100,000.

BOOK REVIEWS.

The new Pocket Electrical Dictionary of Prof. Edwin J. Houston is the fourth edition of his extensive, popular and standard work. This little volume contains over six thousand new electrical words, terms and phrases that have come into use since 1898. The entire volume contains in all about 15,000 definitions. It is certainly the most complete book of its kind in existence and it will be impossible for the electrical engineer to feel up-to-date without a copy of this handy book for reference. It is sold at $3.00 retail with leather binding and $2.50 cloth.

"Lubricants, Oils and Greases," by Iltyd I. Redwood, is a new book published by Spon & Chamberlain, 12 Cortlandt street, New York. This English volume contains a great deal of information on the use of lubricating material. It will certainly find a place in the library of all practical engineers and may serve to modify some of the opinions entertained by certain manufacturers of lubricating oils. The subject is treated in a plain and straightforward manner and shows the composition of many standard lubricants. The subject is treated theoretically and practically and is contained within the scope of seven chapters. Some valuable tables will prove a handy reference and the general classification and tests a source of wholesome instruction.

"A System of Easy Lettering," by J. H. Cromwell, whose editions have now reached the fourth thousand, represents one of the simplest and most easily acquired methods in vogue. Architects and draughtsmen of all descriptions will find this modest little volume of the greatest value to them.

"Algebra Made Easy," by Edwin J. Houston, Ph. D., and Arthur E. Kennelly, Dr.Sc., published by the American Technical Book Company, 45 Vesey street, New York, is exactly what its collaborators call it, a "clear explanation of the mathematical formulæ found in Prof. Thompson's 'Dynamo-Electrical Machinery and Polyphase Electric Currents.'" The earnest student will find that the use of this book "Algebra Made Easy," in connection with Thompson's work, will prove a great aid and save considerable time in the interpretation of the varied formulæ contained therein.

Winnsboro, S. C.—The Winnsboro Electric Light and Power Co. has been fully organized, and will erect a $3,000 electric light plant of 750 incandescent lamps.

Wheeling, W. Va.—The Wheeling Street Railway Co. will increase the power of its electric power plant, putting in new machinery, etc.

Bristol, Tenn.—The telephone system is to be extended.

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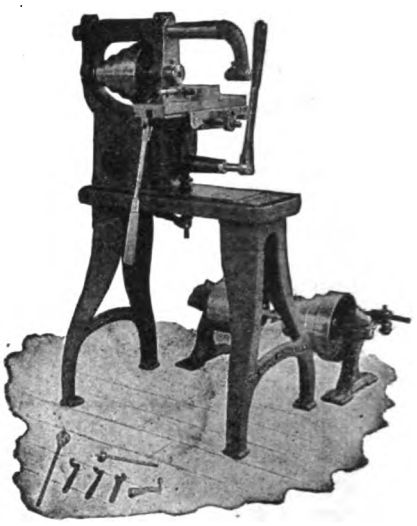

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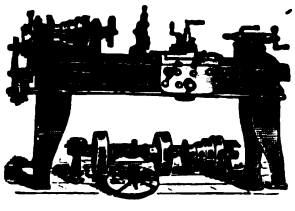

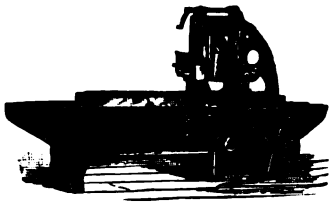

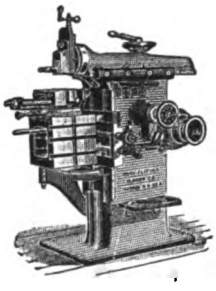

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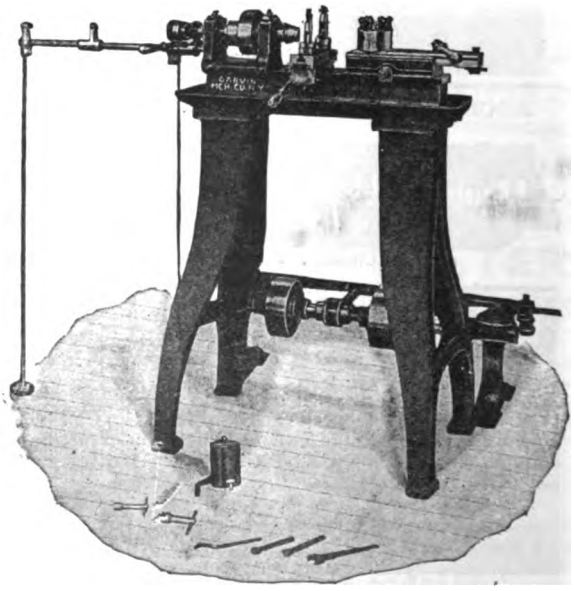

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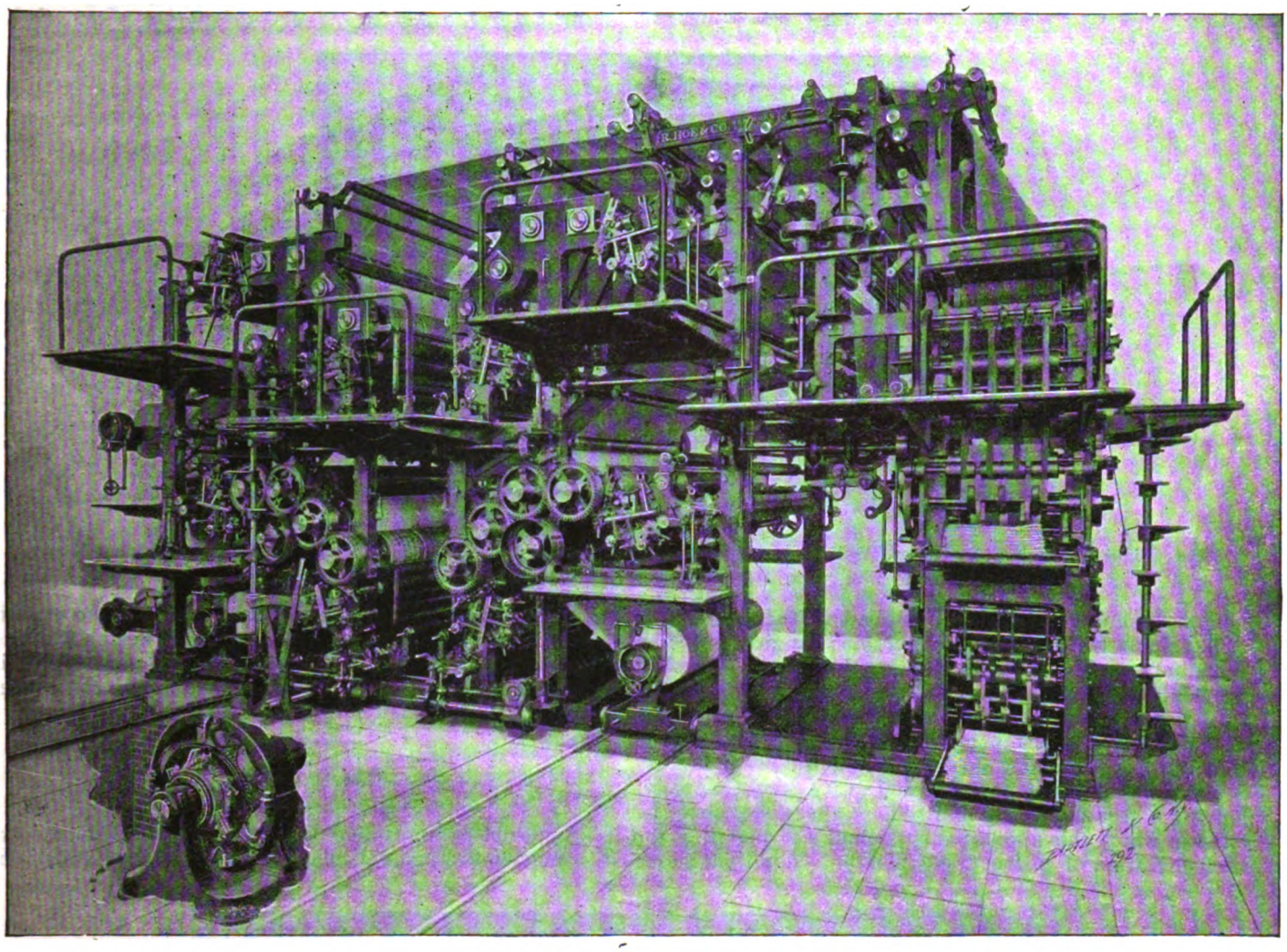
The Electrical Age.

VOL. XXI—NO. 15 NEW YORK, APRIL 9, 1898 WHOLE NO. 569



The Largest Printing Press Ever Built.—Driven by a Crocker-Wheeler Motor. Octuple Stereotype Perfecting Press and Folder, by R. Hoe & Co.

SOME APPLICATIONS OF CROCKER-WHEELER MACHINERY.

The development of electrical or mechanical energy two great classes of machinery—dynamos and motors; and we find as circumstances arise in industrial life requiring special applications of either one or the other, that the mere design and construction of an ordinary motor or dynamo would not suffice. We may regard the Crocker-Wheeler Electric Company as representing the spirit of true progress, not only in the manufacture of many varieties of electrical machines, but in discovering original applications of them. For many years in the past, when the science of electrical engineering was incomplete, this concern pursued its most conservative policy and kept in mind with remarkable persistence this object. Since then a vast field of experimental work has been passed and its nooks and crannies carefully explored, so that it may now be said that a period of maturity has been reached, and the ripened products of a well-established growth are at hand ready for public service or individual use. The spirit of the times demands a constant wakefulness on the part of electrical manufacturers, for the future growth and prosperity of those engaged in the art depends entirely upon themselves. In looking over the advances made in the course of the last ten years, examination will show that even in the lesser departments of work, as well as the higher, the above company has always been to the front.

Some illustrations have been attached to this article for the purpose of showing in a slight degree the nature of the work now undertaken by the Crocker-Wheeler Electric Company. The largest printing press ever built is being driven by a Crocker-Wheeler motor. This press was constructed by R. Hoe & Company, and is an octuple, stereotype perfecting press and folder. It prints, folds, counts and delivers 96,000 eight-page newspapers in an hour. As seen in the illustration, a 75-horse power motor built by the Crocker-Wheeler Electric Company, of Ampere, N. J., and 39-41 Cortlandt street, New York, has been installed under the floor for direct connection to the gigantic press above it. Relative sizes of both are well represented. This plant was installed by Blackall & Baldwin, 39-41 Cortlandt street, New York, selling agents for the Crocker-Wheeler Electric Company.

In connection with printing, it may be well to state that the greatest strain comes upon a motor at the instant of starting, and the motor must be well designed to stand the load at that and for a few moments after. In this case absolute satisfaction has been given, and this mechanical monolith owes its living force to the electric motor beneath. In other cases smaller presses have been operated; a size 2 Huber color press is being driven by a Crocker-Wheeler motor; another operating a number 9 Scott press, with the bed 42 by 60 inches.

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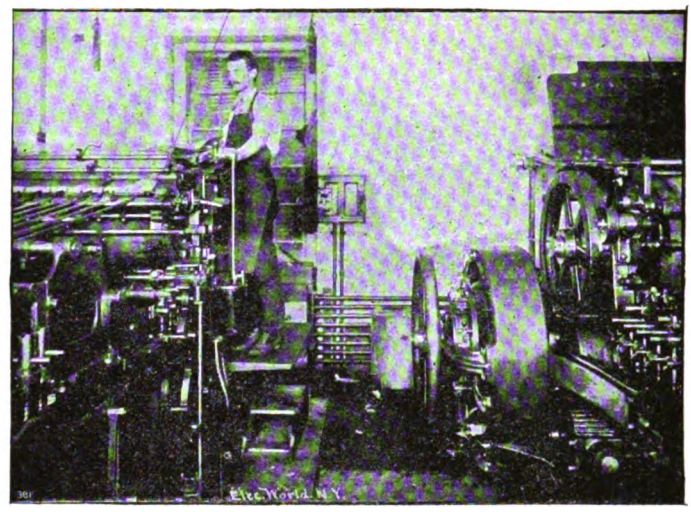
The Crocker-Wheeler Electric Company have excelled themselves in the construction for electric lighting. Illustrations show a 6½-K. W. bi-polar direct-connected to a Case engine operating at a speed of 550 revolutions per minute, and a lighting plant installed at the Bartram in Philadelphia with direct connection; engines of the Woodbury style. This is one of the finest plants in Philadelphia, and has operated like a watch ever since installation. The Crocker-Wheeler Electric Company have had occasion to design motors for heavy work, and as seen in illustration one of their automatic break motors is to-day in operation at the Granite City Steel Company, moving a great blooming mill roll. Other cases could be cited in which this apparatus has found a place either for the generation of power or electricity. On all occasions the machines installed perform their function without aggravation to either manufacturer or purchaser.

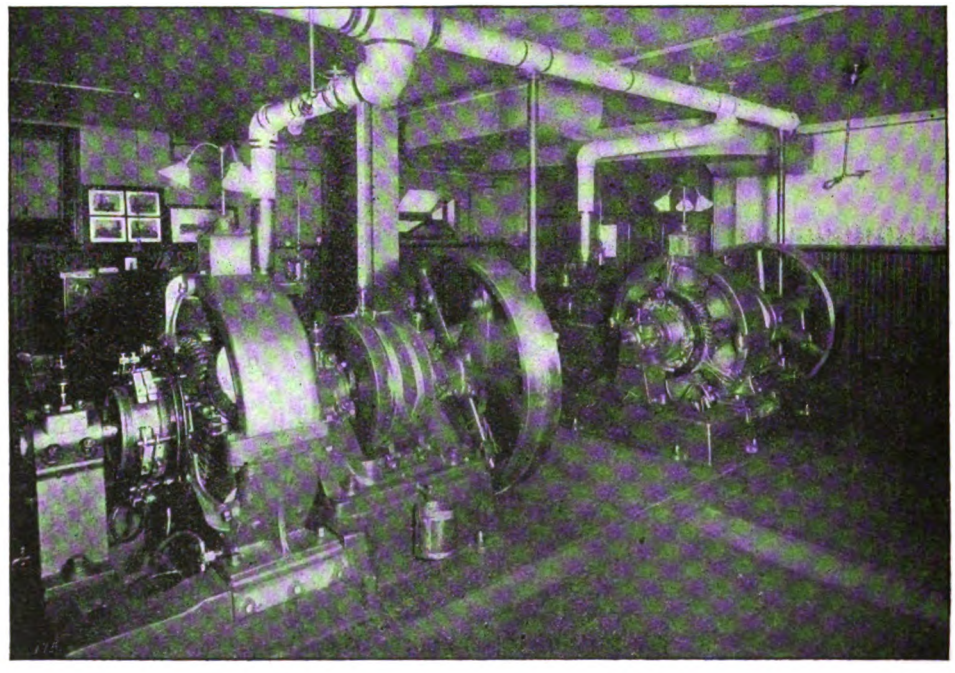
The Crocker-Wheeler Electric Company were the first in this country to attach a special motor to each tool in their shop, thereby becoming independent of any main shaft, saving the loss of power consumed in its mechanical transmission, and giving each tool an independence of action which only necessitated its operation when required for use. Large machine shops requiring an equipment of a most advanced order will find that the experience of the engineers of the Crocker-Wheeler Electric Company is invaluable in this respect, and can have their own machinery driven in the same manner with the consequent economy which naturally results.



Size 2 Huber Single-Color Press, Bed 36x54, Showing Controller Side, Operated by Size 3-100 Crocker-Wheeler Motor, and Size 3-100 Motor Operating No. 9 Scott Press, Bed 42x60.

PRIZE ESSAYS.

A special committee of the Auxiliary and Educational Committee has just drawn up, on behalf of the Exhibition, a plan whereby prizes to the value of not less than $100 are offered to the pupils in the public and private schools in New York and its vicinity for essays on the Electrical Exhibition. This committee, comprising Prof. F. B. Crocker, Mr. G. H. Guy and Mr. T. C. Martin, has re-



Lighting Plant at "The Bartram," Philadelphia, Pa. Two Size 56 C.-W. Dynamos Direct Connected to Woodbury Engines.

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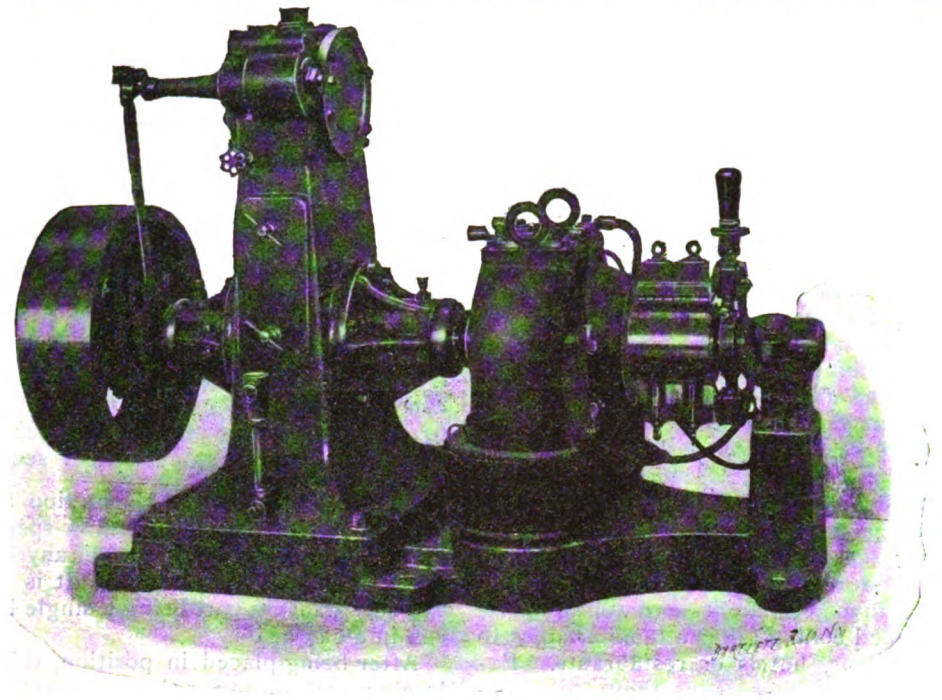
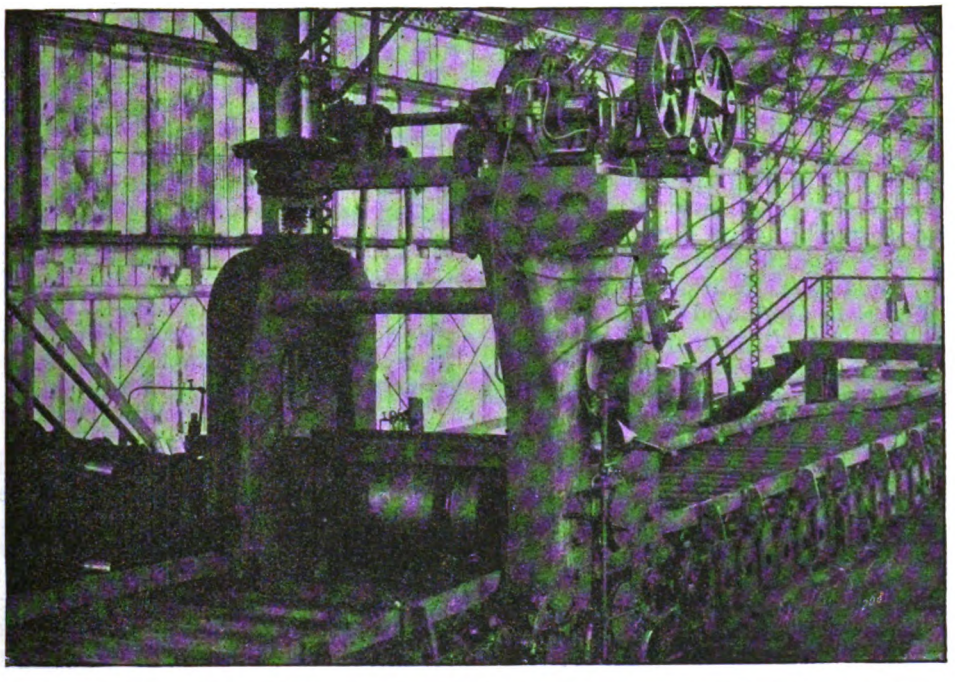
alized the fact that a great many young people will visit the Exhibition not merely from idle curiosity, but from a desire to learn, and it is believed that many such visitors will be encouraged in this way in their intelligent study of electrical principles, phenomena and inventions. The essays will be limited to 1,500 words, and will be accepted up to May 18th, the awards being declared and prizes presented not later than May 28th. No contestant is to be over sixteen years of age, and the judges will be selected chiefly from the staff of the college and schools of New York City. Copies of the circular will be ready this week.

The desire of the society to promote the welfare of electrical applications is recognized as highly laudable, and has elicited not only many words of commendation but has brought the largest numbers of applications for membership within a given time that the society has known in its history. Last month the secretary announced a list of a round score of new members, and he now states that the applications for March should reach close upon fifty. In almost every instance the new members inquire as to the Exhibition and express the wish to aid it in any way possible.



Size 10 C.-W. Dynamo, Direct-Connected to No. 5 Case Engine. Output, 6½ Kilowatts. Speed, 550 Revolutions per minute. Weight, 1700 Pounds.



C.-W. Automatic Brake Motor, with Counter-Shaft Through Base, Geared to "Screw Down" on Blooming Mill Rolls, Granite City Steel Co.

One of the most striking evidences of the general interest that the Exhibition is awakening is to be found in the remarkably large accession to its membership which the New York Electrical Society has enjoyed since the Exhibition was announced under its auspices.

Washington, D. C.—The Electrical Railway Equipment Company has been incorporated, with Archibald Greenlees, of Washington, as president, for the manufacture and equipment of electric railways. Capital stock, $100,000.

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THE LATEST FANS AND VENTILATORS.

We enjoy to-day a luxury of which our forefathers knew nothing. The electric fan has entered the home, the theatre, the restaurant and business office; in the hospital, the fever patient has felt its grateful breeze and heard its busy hum with inexpressible gratitude. It is not many years since the electric fan or ventilator was a luxury that might be more expected in the sumptuous chambers of some magnate than in the home of the middle class, yet we find, since the various applications of electricity have been recognized and appreciated, that the great middle class may have electric lights and fans without great expense. In fact, we find that the use of fans for the expulsion or introduction of air has become so universal that the fan industry may be regarded as a permanent institution, one that has branched out suddenly and successfully as one of the great departments of electrical engineering.

We find now that manufacturers all over the country are running full blast to meet the coming demand for electric fans, and it is necessary for those dealers expecting heavy orders to place their own with the manufacturers proper months before the hot season sets in.

Fans, as we find them, driven by electricity, are divided up into three general classes. First, fan motors running at a very high speed; second, long-bladed ceiling fans; third, exhaust or pressure fans. The high-speed fan motor finds its place in offices, homes and dining apartments. The long-bladed ceiling fan is a familiar sight to those visiting either shops, hotels or restaurants. Exhaust and pressure fans, or blowers, as they are sometimes called, may be discovered in basements, engine rooms and other places where a forced draught is necessary in order to provide circulation and expel the hot air.

GENERAL ELECTRIC CO.'S FANS.

The '98 models of the General Electric Company's fan motors are announced as the latest of a long line of successful designs. These fan motors are built for both alternating and direct-current circuits.

That for alternating currents is an induction motor, as carefully proportioned in all its parts as are the larger machines which this company builds, excessive wear and heating under continuous operation being as absent from the small as from the large. To the cast-iron frame, which supports a single long bearing, are bolted the soft iron laminations which make up the field core, provided with inwardly-projecting teeth to form the poles on which are placed the field coils wound with an ample quantity of wire and thoroughly insulated. The armature is built up, also of soft iron laminations, assembled on a brass spider, but has no insulated wire. Bare copper rods run through the core, and are rivetted into disks at each side. Rotation being produced by inductive action, no commutator or brushes are required. The armature overhangs the bearing, and, with the fan, rotates well-balanced on the single bearing. An automatic oiling device gives perfect lubrication without oil-throwing, and this, together with the long bearing, ensures continuous cool operation.

The alternating fan motor is built for 52 and 104 volts, 60 and 125 cycles, and is provided with a speed-regulating device consisting of an inductive resistance cut in or out by a three-point switch. Movement of the switch over the first two points gives full speed and half speed and on the third cuts the motor out of circuit. No additional switch is necessary.

The direct-current fan motor is as equally compact and carefully designed as that for alternating currents and in appearance and general construction closely resembles it. Laminated soft iron of the best quality is used throughout for the magnetic circuit; all windings are thoroughly insulated, and commutator connections carefully made. As in the alternating motor, fan and armature revolve in a single, long, self-oiling bearing. The commutator is completely enclosed, and the carbon brushes encased in small tubes, readily unscrewed for inspection. A regulating switch provides for variation of speeds. The alternating current fan motor may be, if desired, mounted on trunnions to allow of adjustment of the fan to blow in any direction.

The motors are finished in black enamel; the fan guard and trimmings in polished nickel.

EMERSON ALTERNATING CURRENT FAN MOTORS.

The Emerson Electric M'f'g Co., of St. Louis, Mo., are placing on the market a complete line of alternating current fan motors, both for desk use and ceiling fans. The desk fans are made in two sizes, 12 and 15-inch, and two styles of ceiling fans are made; one two-bladed, making from 200 to 210 revolutions per minute, and being for 60-cycle systems; the other, a five-bladed type, making 500 to 600 revolutions per minute, being for high alternations from 125 to 133 cycles per second.

Ceiling Fan for Low Alternation Systems.—This ceiling fan is a direct-acting, slow-speed, induction motor without speed-reducing gear of any kind, and also without commutator or brushes. It is absolutely noiseless, the only wearing part being a single ball bearing which is run in a cup of oil.

After being placed in position, this fan requires absolutely no attention for the entire season, if the oil-cup is filled at the beginning of the year. The finish of this fan is very tasteful and rich, the body of the fan being in expensive black enamel with gold decorations, hanger and trimmings being finished in highly polished and lacquered brass. This fan is regularly furnished in the above-described finish adapted for 12-foot ceilings without light fixture, but can be furnished promptly in nickel or oxydized copper finish with light fixtures for 2, 3 or 5 lights, as ordered, and can also be furnished with hanger rods for any desired height of ceiling.

The current consumption of this machine running at the highest speed (210 revolutions per minute) is 125 watts. A second speed is also provided for by which the motor runs at 150 revolutions per minute, with a current consumption of 100 watts. This is the type of machine which is regularly furnished. For special uses, we are prepared to furnish this machine with a current consumption of 150 watts on the high speed, giving a correspondingly large volume of air.

Twelve-inch Desk Fan Motors.—The general appearance of this motor has been changed entirely from their former type, and the mechanical construction has been changed in a way which the manufacturers believe will be a decided improvement.

The shaft of these motors is pressed firmly into the back cover and is made of ½-inch bicycle tubing, which is case-hardened and ground accurately to size. The armature hub is composed of a large piece of bicycle tubing, into which is pressed at either end a brass bushing.

This bushing is reamed out to accurately fit the hardened steel shaft. This shaft being of much larger size than has ever been used in fan motors in the past, and from the fact of its being hardened steel will wear for an indefinite time, thus avoiding all rattle and noise.

Another improvement lies in the switch-plate, which is made of porcelain, the binding posts being so concealed that it is absolutely impossible for inexperienced persons to receive a shock in handling the motor. The 12-inch size of desk fan is carried regularly in stock for any voltage and number of alternations.

The current consumption of this motor is the same as their 1897 type, the 12-inch motor consuming on the

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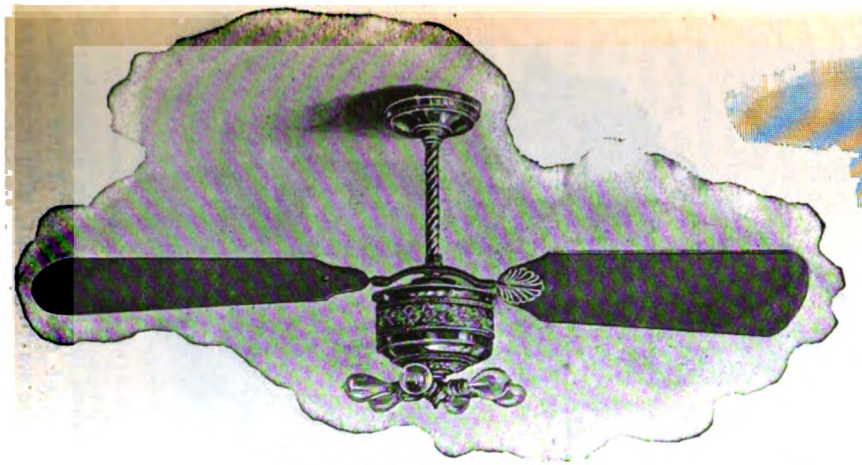
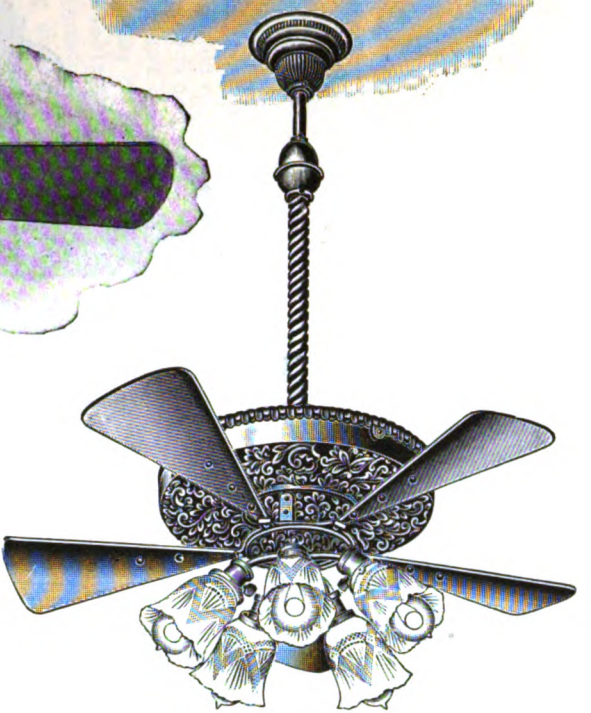
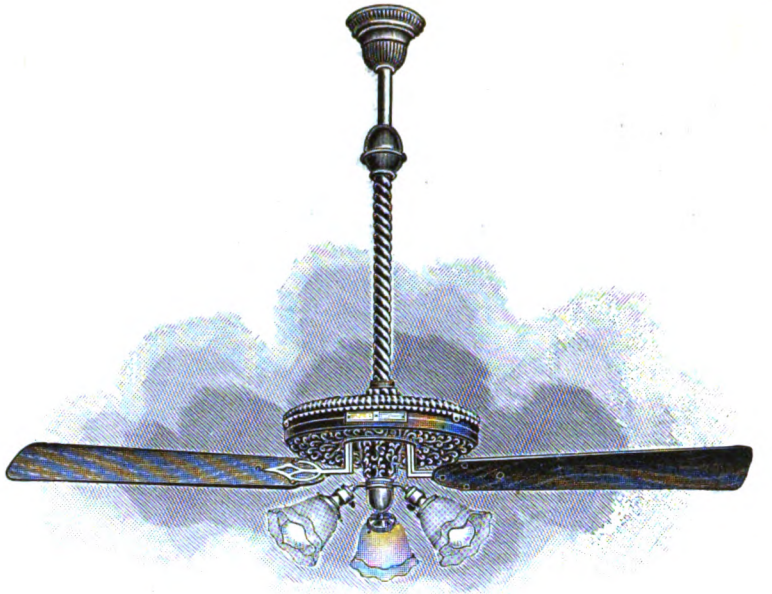


Lundell Ceiling Fan Motor.

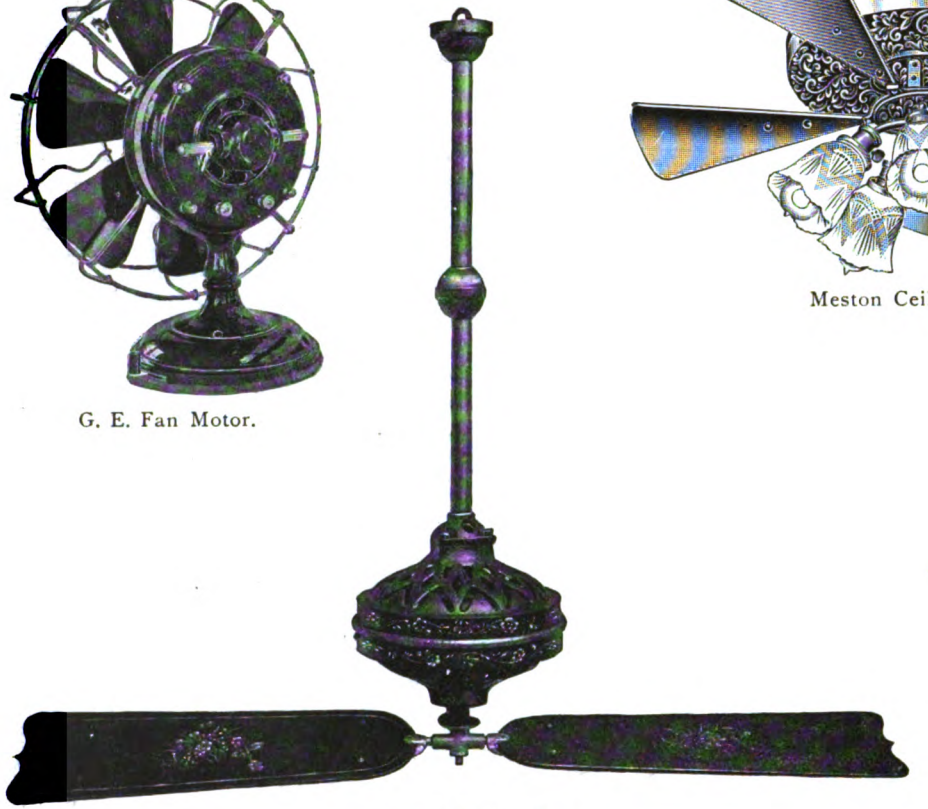


Meston Ceiling Fan.



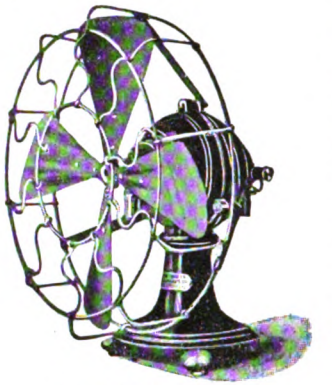
Meston Ceiling Fan.

G. E. Fan Motor.

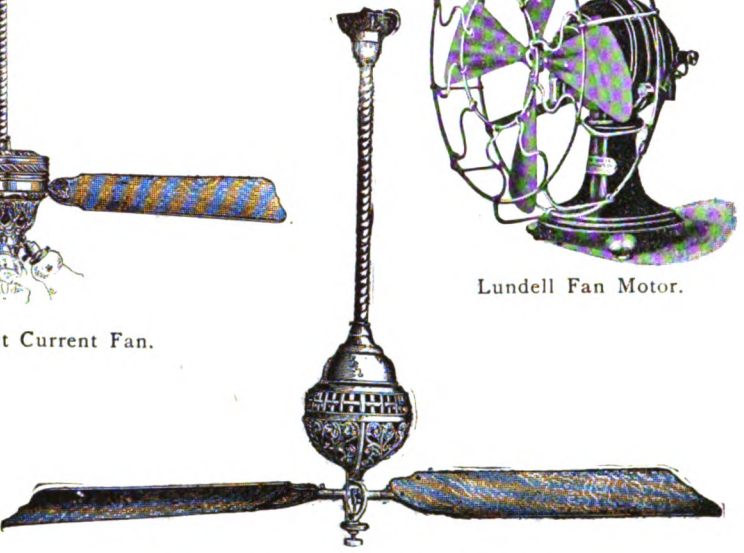


Paragon Ceiling Fan.

Latham Direct Current Fan.



Lundell Fan Motor.



Latham Alternating Current Ceiling Fan.

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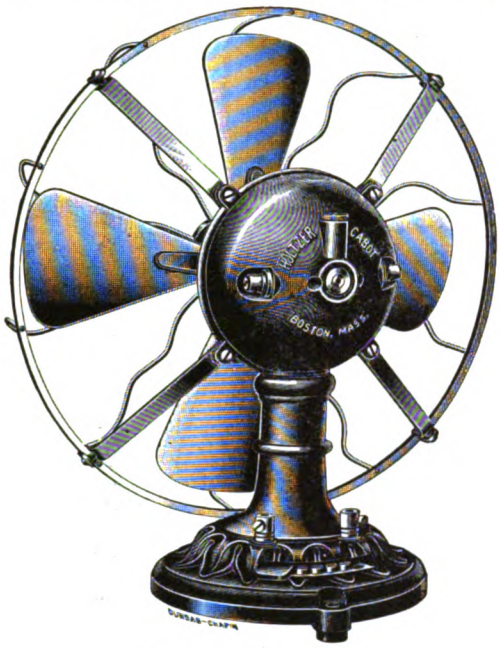
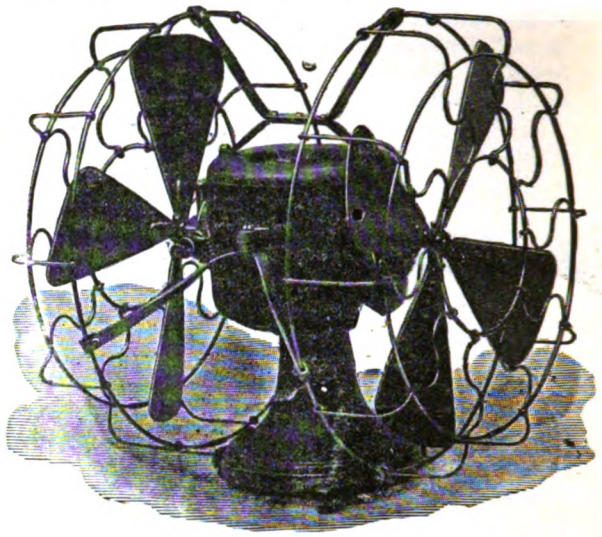
start from 65 to 70 watts, running at about 1,550 revolutions per minute. By turning the switch over to the position marked "ON," the consumption of current is cut down to 50 watts, while the speed remains almost the same; while by moving the switch to the position marked "SLOW," the current consumption is cut down to about 35 watts and the speed to about 950 revolutions.

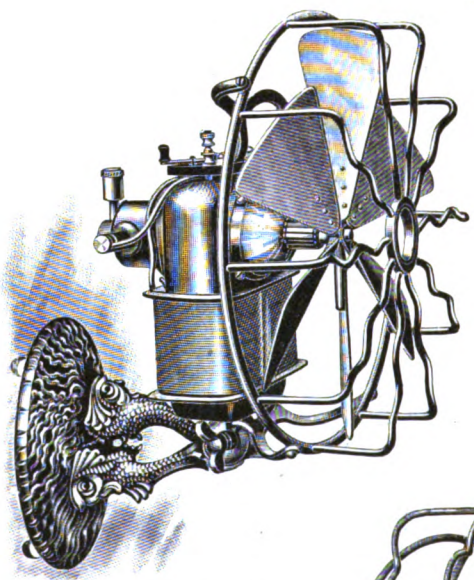


Holzer-Cabot Electric Co.

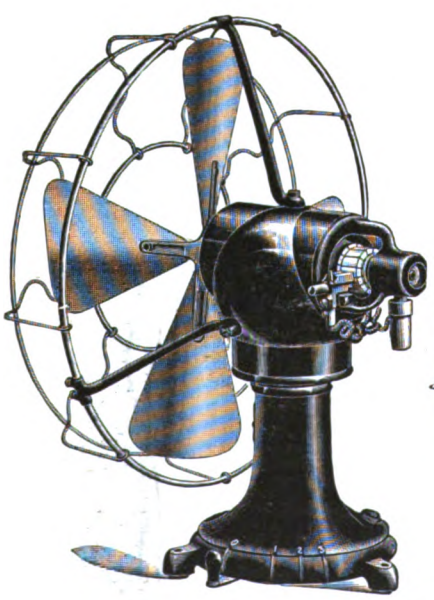
Fifteen-inch Desk Fan Motors.—The 15-inch fan has four blades, while the 12-inch has five. In other ways, the appearance of the two machines is identical. This 15-inch motor is carried regularly in stock for 7,200 and 16,000 alternations, and for 52 and 104 volts. Machines, however, can be furnished for any voltage or number of alternations. The current consumption of the 15-inch motor is 110 watts on the starting point, with revolutions of about 1,550 per minute. Moving the switch over to



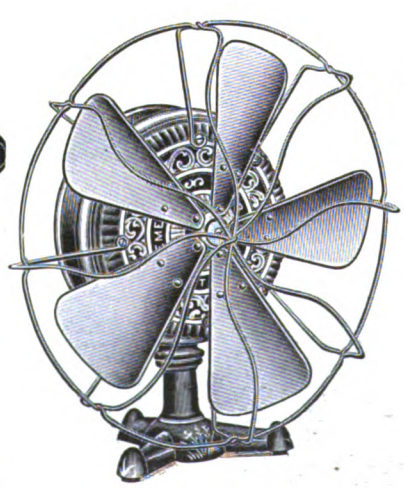
"Paragon" Fan Motor.



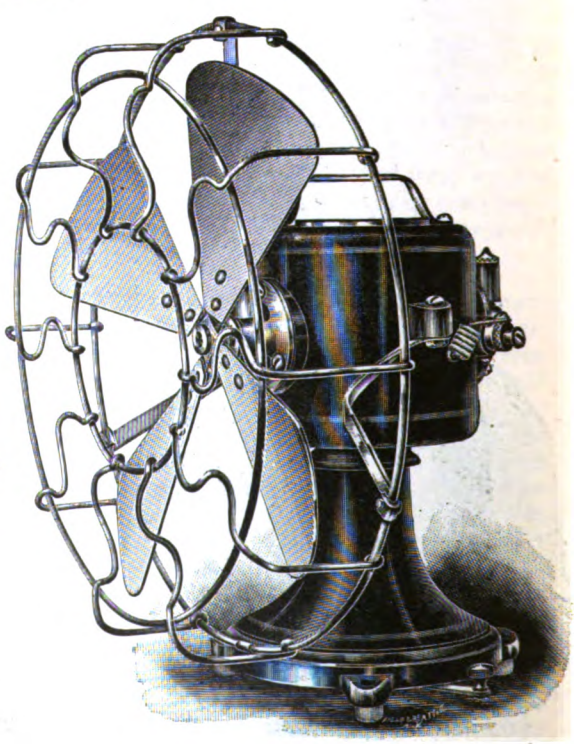
"Noxall" Fan, Vance Elec. Co.



"Hurricane" Fan Motor.



"Meston" Fan Motor.



"Paragon" Fan Motor.

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SUBMARINE WAR VESSELS.

The Holland submarine boat, invented by Mr. John P. Holland, has awakened wonderful interest in this country for several reasons. It shows the tremendous advantage possessed by a vessel of this description over one floating on the surface of the water. It proves that the construction of submarine vessels which can be perfectly controlled is no longer a matter of experiment, and in addition shows that warfare in the future, when carried on at sea, may be like the battles of great cetaceans.

The subject of submarine vessels should certainly be an interesting one to electrical engineers, experience having shown how necessary electrical apparatus is for driving the boat and performing other important functions in relation to manœuvring. The Holland submarine boat is probably the most successful of its kind in existence. It is the only one under such control as to be able to dive, rise, turn or move with absolute certainty of action. Many attempts have been made in the past to construct submarine boats.

Considerable furore resulted from the construction of an electric boat of this kind in 1888, invented by Lieut. Peral, of the Spanish navy. It was 72 feet long, was operated by storage batteries and moved at a speed of 11 knots an hour. The "Gymnóte," invented by M. Zédé, chief engineer of the Forges et Chantier de la Méditerranée, working under the French Government was another. In this vessel electricity was the motive power, the total length being 59 feet, the maximum speed 10 knots an hour. It was presumed by the French Minister of Marine in 1891 that the "Gymnóte" left nothing to be desired in submarine navigation. It was then proposed to build a new vessel equipped with armaments which would cost about $250,000.

In many respects the Holland submarine boat possesses features similar to those combined in the operation and construction of the Baker boat, invented by George C. Baker, of Chicago. It was tried in 1892 and was operated by storage battery when under water and steam power when at the surface. When descending, the smoke stack was pulled in and the air-tight doors closed, the fires shut off, and the dynamo, previously charging the storage batteries, was operated by them and drove the boat. This unique vessel at a certain test remained nearly three hours under the water, with several men on board, including the inventor, and is mentioned by the U. S. Navy Department in flattering terms.

The Holland, which embodies the results of twenty years' experience, is fifty-five feet long and moves at a speed of eleven knots an hour. It is driven, when on the surface, by a gas-engine, and a motor propels it when submerged. Tanks filled with compressed air supply the vessel when under water, and in this case, as in that of the Baker boat, the motor is used to charge the storage batteries with when the vessel rests upon the surface. This triumph of engineering will project a hundred pound gun-cotton shell three-quarters of a mile through the air or two hundred yards under water. A vessel of this description is more formidable than the largest ironclad afloat, because of the wonderful facility with which it can approach unseen and the unerring precision with which it delivers its projectile against the unprotected bottom of unfortunate vessels. Mr. Holland utilizes the Whitehead torpedoes for purposes of attack, which carry their own motive power with them and cannot fail to strike at whatever they are directed when set off at a distance of six hundred yards from the object to be destroyed.

The U. S. Navy has been greatly impressed in the past with the necessity for adding to her naval force such vessels as these, and the Holland submarine boat, perfected at this opportune moment, will certainly lead at once to the immediate construction of several others. In fact, the protection of any sea-port by means of a few submarine electric torpedo boats would absolutely prevent the approach of even the most powerful vessel built, for advance in such a case would mean inevitable destruction. For military and naval purposes the applications of electricity have increased in number year by year to such an extent that the future of any nation when engaged in war will depend entirely upon the inventive power of its citizens as much as upon their wealth, bravery or patriotism. There is no better means of protecting the coast of the United States than a line of submarine vessels stretching from Maine to Florida and from Washington to Lower California.

THE ABSOLUTE DETERMINATION OF RESISTANCE.

The first absolute determination of resistance was probably that made by Kirchhoff about fifty years ago. Weber published his method in 1852, and then came the B. A. determination by Maxwell, Stewart and Jenkins in 1863. Neither of these were very exact, but they paved the way for the splendid exhibitions of experimental skill which followed. Among those to whom we are most indebted for this later work may be mentioned Kohlrausch, Rayleigh, Glazebrook, Rowland, Wiedemann, Mascart, etc. The greatest step in advance in recent years has been the invention of the revolving disk method of Lorenz of Copenhagen, and its subsequent improvement and application by himself and J. V. Jones. The determinations made by the latter by this method are probably almost absolutely correct. [From "The Development of Electrical Science," Prof. Thomas Gray.]

Manwaki, Que.—A company has been formed for the purpose of supplying electric light. The directors are Charles Logue, J. P. Tremblay, Dr. Mulligan and Rev. Father Laporte.

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the point marked "ON," reduces the current consumption to 90 watts and the revolutions to about 1,500.

For the accommodation of such patrons as used their 1897 type of motor and prefer that type, they will also manufacture their last year's type of motor, and are prepared to furnish either style promptly on short notice.

LUNDELL FAN MOTORS.

The direct and alternating-current fan motors now being manufactured by the Sprague Electric Company, 20–22 Broad street, New York, have met with such popularity in this and other large cities that they have now become a most familiar accessory to the equipment of hotels, restaurants, cafés, etc. These fan-motor outfits are beautifully decorated with black japan and gold stripes. The method of regulating them is very simple; a switch giving three speeds of 1100, 1400 and 1800 revolutions per minute in the one-twelfth horse-power model and of 800, 1200 and 1500 in the one-sixth horse power model. They are wound for 110 volts and possess auto matically lubricated bearings which are self-aligning and therefore require little or no adjustment. The exposed metal parts, including the fan guard, oil-cups, etc., are either polished or nickeled, thus making the machine, when complete, a handsome, compact and quiet running motor. The efficiency of these machines is high and the convenience with which they may be set up either on the desk, ceiling or wall, leave nothing to be desired.

The brushes of the Lundell fan motors are automatically fed forward, and an even pressure sustained by means of a spiral spring fitting within the brush-holder. By writing to the company a catalogue will be sent containing sketches of each part, and thus illustrating the detailed finish of each part. The Lundell ceiling fan motor outfits dispense with shafting and belting and operate at a slow speed.

The fan from base to tip are four to five feet long, or longer if so ordered. The average speed is thirty-five revolutions per minute the voltage ranging from 110 to 250 in the one-sixth horse-power size. The electrolier ceiling fan motor performs the function of giving a breeze and light at the same time. The blades are made of varying lengths and widths to suit.

The column fans of Lundell design have been installed in many prominent places throughout the city. They are supplied with hooks, if so desired, for clothing, hats, etc., and are made any height required. The Lundell alternating fan motor outfits are designed for wall and desk use, operate at a pressure of 52 and 104 volts, having a speed of 1200, 1400 and 1600 revolutions per minute. The frequency of the alternating current to be supplied to them is between 14,000 to 16,000. The speeds are controlled by means of a switch, and the general mechanical details correspond to those of the continuous-current motor. The Sprague Electric Company report an unusual demand for their goods from all over the country.

TUERK'S ELECTRIC CEILING FANS.

Ceiling fans constructed for use on alternating as well as direct-current circuits are being manufactured by E. B. Latham & Co., of 136 Liberty street, New York. The direct-current ceiling fan is made for two speeds, 135 and 190 revolutions per minute. The blade sweeps through sixty inches and its width is eight inches. They run noiselessly and produce a strong, even gust of air. They are wound for 110, 170, 220 and 500 volts pressure; ornamenting with or without electrolier as desired.

The direct-current fans have self-oiling bearings. A switch at the bottom, within handy reach, will start or stop them at the proprietor's pleasure. It is almost unnecessary to say that their great efficiency has made them very popular with current consumers because those having experience have found out that with an equal consumption of current they will move more air than any other fan on the market.

The Tuerk alternating ceiling fan of the 1898 model rotates at a speed of 150 revolutions per minute. It has a five-foot sweep of blade, the blades being eight inches wide. These fans are made for 140, 125 and 60 cycles per second and wound for a pressure of 52 and 120 volts.

Both the direct and alternating-current ceiling fans are handsomely ornamented, and when once installed require little or no attention during the season. The purchaser will discover by consulting the ammeter or wattmeter that both of these fans take but little power and run with a cheapness and economy that, commercially speaking, cannot be excelled.

E. B. Latham & Co. will send catalogues, prices and further information to those desiring to correspond.

"PARAGON" FAN MOTORS.

Many manufacturers expressed considerable curiosity in the fall of 1897 as to which would be the handsomest and most popular fan motor in 1898. The motors exhibiting all these good qualities are the "Paragon," especially their handsome new ceiling fan. It is not alone the durability of a motor which counts in the long run, but likewise a certain internal quality which in motors, as in men, creates differences between them. The "Paragon" fan motors possess very high efficiency, which, of course, follows from the nature of its design. It is a motor whose appearance, construction and economy of operation are in perfect harmony with each other.

No word of criticism has ever been passed against the appearance of the "Paragon" fan, and as regards its construction its manufacturers guarantee a perfect interchangeability of parts, so that if by chance or accident renewals are necessary of either brush-holders, brushes, bearings, commutator, etc., a note to the company will immediately bring back that which was required to be immediately applied where needed.

The "Paragon" fan motor driving a 12-inch fan consumes the current of an ordinary incandescent lamp; the 14-inch outfit and the 16-inch but very little more. The frames of these machines are made of soft-grade cast iron; its armatures built up of the best Swedish wrought iron. The brush-holders produce upon the commutator, through the medium of flat carbon brushes, a uniform pressure, being automatic in this respect. Being entirely enclosed within its own shell or frame, the "Paragon" motor is dust-proof and free from external injury. The windings are so proportioned that excessive heating is impossible, and the "Paragon" fan motor more than deserves its name, because in its history it has never burned out.

Mr. J. P. Williams, general agent for the "Paragon" fan and power motors, of 39 and 41 Cortlandt street, New York, also handles the "Paragon" ceiling fan motor, with a 60-inch sweep, wood blade, ball bearing, switch on bottom, of both the 110 and 220-volt type. The 110-volt ceiling fan takes six-tenths of an ampere at 175 revolutions per minute. A unique type, called the "Paragon" duplex fan, operates two fans at once. It is made for 12 and 14-inch desk and bracket outfits. The fan motors proper, driving 12 and 14-inch fans, are built for 110 and 220 volts respectively. The "Paragon" 16-inch fan motor is wound, if ordered, for 500 volts.

Trade in these motors has grown to great proportions in the last year, and one of the most familiar sights to cafe frequenters, commercial travellers and business men is the "Paragon" fan motor.

Williamsport, Md.—J. Thompson, Mayor, may be addressed concerning electric lighting.

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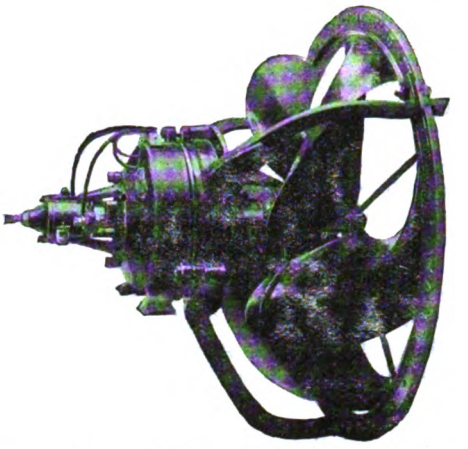
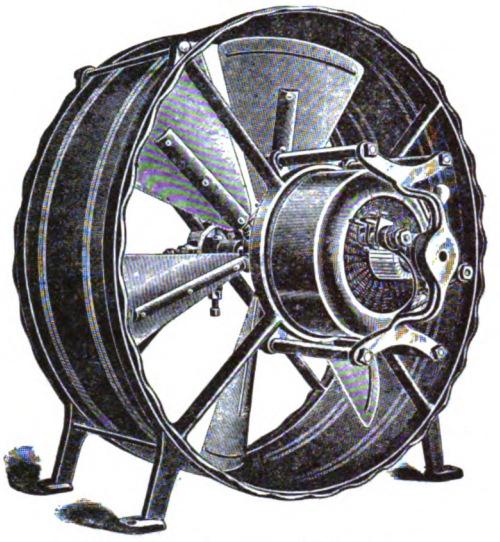
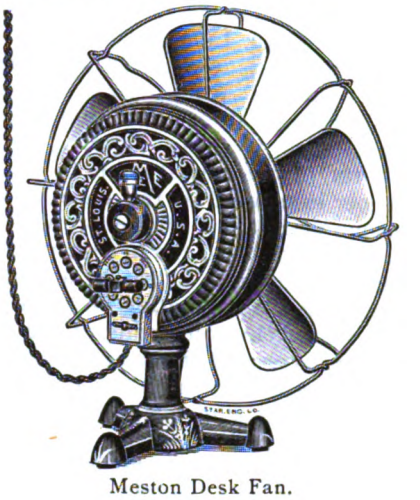
Lundell Motor, Blackman Fan.



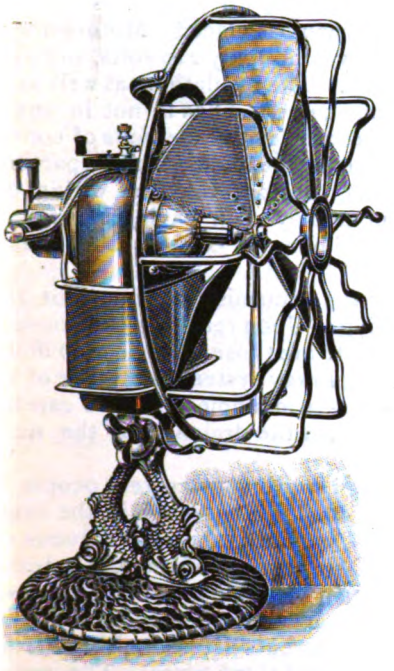
Lundell Motor, Davidson Fan.



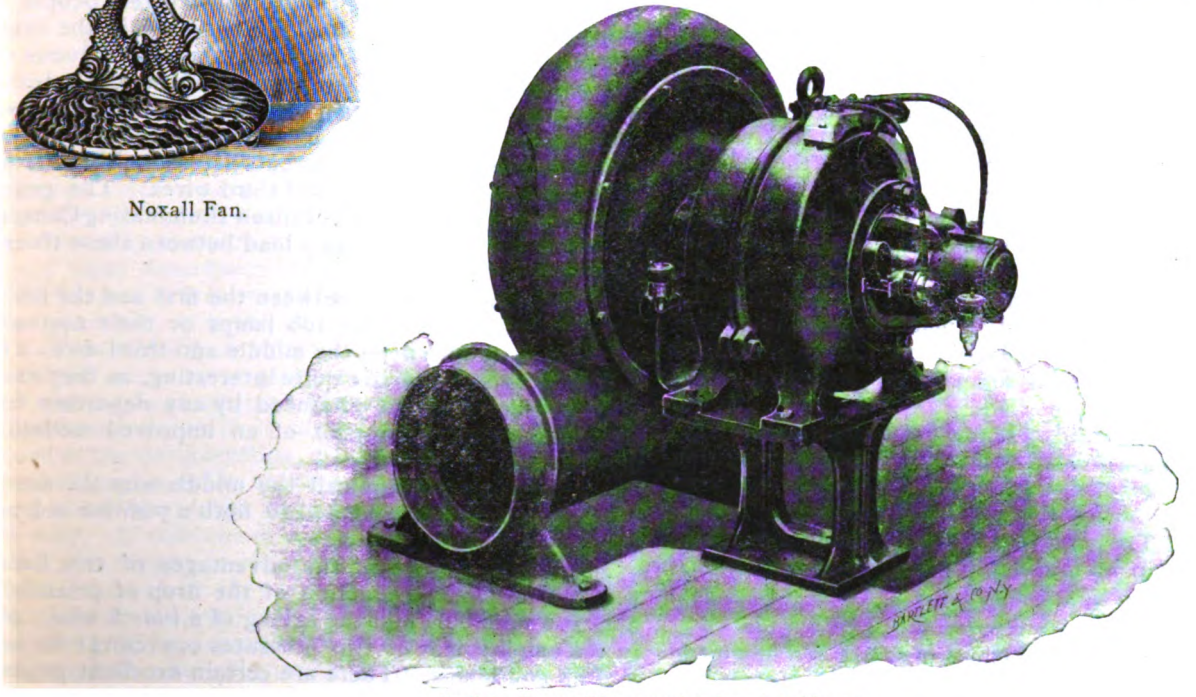
Wing Disc Fan with Diehl Motor.



Meston Desk Fan.



Noxall Fan.



Buffalo Forge Blower with Lundell Motor.

H. C. FAN MOTORS.

A fan whose reputation has always insured it a ready sale, so that it may be regarded during the fan-motor season almost in the light of United States specie, is that manufactured by the Holtzer-Cabot Electric Company, of Brookline, Mass., whose New York salesrooms are at 114 Liberty street. To speak plainly, its greatest characteristic is that of requiring no attention during a season's run. It operates with a gentle hum, and does not throw out a heated blast, because the winding is so proportioned that no rise of temperature of any consequence occurs in either armature or field. The general public are not in the habit of buying fans that require much care, and although a good salesman may persuade them to make a trial, he will find that in the end, unless the fan be good, the trial was made at his own expense. The experience of those handling, selling and buying the H.-C. fan has been of so satisfactory a nature that it is safe to say that in every case the fans have done their duty and been a letter of recommendation to the manufacturers wherever installed.

Dealers in electric fans frequeutly hunt for low prices

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instead of good quality. Those that do are not far-sighted. Those that do not, but only touch fans which are compact, noiseless, efficient and handsome are certain to acquire a trade which will develop in the future to large proportions. The Holtzer-Cabot Electric Company, in placing their goods before the public, do so with full confidence in the superior quality of their fans and a knowledge that all they claim in connection with them will be proven to the letter.

Their latest types, consisting of wall motors and desk fans, are selling so rapidly that they expect unusual sales before the season is over. They will be pleased to give full information to prospective purchasers if their correspondence is directed to the above address.

"Noxall" Fan Motors.—One of the handsomest fan motors on the market at present is the 1898 model "Noxall," manufactured by the Vance Electric Company, of 136 Liberty street, New York. The same combines art, symmetry and true mechanical principles, without losing sight of the essential element of perfect design. The motor is mounted on a heavy base, thus insuring rigidity, and at the same time admits of an adjustment to 30 degrees. The motor proper is secured to the base by two dolphins of a grotesque design and of the proper length in order to give the fan and guard the necessary clearance from the base. The two supports admit of and provide ready means of adjusting the inclination of the motor. This adjustment also allows the converting of the fan from a pedestal to a bracket type and vice versa, proper means being provided in the base to secure the fan to the wall. The Vance Electric Company will supply a revolving base for a slight addition in price.

The pole pieces of the motor are of mild steel, all exposed parts being highly polished and nickel-plated. The armature is of the iron-clad, slotted, Paccinotti type. The commutator is constructed of hard-tempered copper, several features in the same securing long life and reducing the possibility of sparking to a minimum. The bearing case at the commutator end carries the brush holders, the carbons used securing even contact and self-lubrication. The journals are long and self-lubricating, there being enough grease in the cups to last one season. A six-blade fan is used, with extra large spider carefully secured to the shaft by set screws. The guard is heavy and strongly made, and easily removed from the motor frame, if desired. The switch is mounted on hard rubber across the pole pieces, on the top of the machine, and allows of three speeds, namely, 900, 1,400 and 1,800 revolutions per minnte. Lower speeds are also supplied, if desired, on special order.

All fans have exposed parts, except base, which is oxy dized bronze, nickel-plated, which give them a very rich appearance. The efficiency of the fans is of the very highest, the following table showing efficiency of the various sizes: Twelve-inch fan at maximum speed, 43 watts; 14-inch fan at maximum speed, 70 watts; 16-inch fan at maximum speed, 96 watts.

The Wing Disk Fan.—The Wing disk fan has made an enviable reputation for itself as one of the earliest pioneers in the art of ventilating. The electric motors which drive them are practically part of the fan they operate and consume the least possible power. When inserted in windows the light is not interfered with, and their noiseless operation makes them extremely desirable. The Diehl Manufacturing Company of Elizabethport, N. J., have adopted this excellent fan in connection with their motor, making an extremely efficient combination. The blades of this fan, as may be seen in the sketch, are attached so firmly to the radial driving arms that they can never fly out and can be set at any angle. Their solidity of attachment also prevents vibration and sends forward a powerful blast of air. The Wing fans are used in innumerable places. A few of them are hotels, restaurants, laundries, mills, mines, cold storage rooms, etc. Address 109 Liberty street, N. Y.

WIRING FOR LIGHT AND POWER.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

The Edison Illuminating Company employ a special system or network of conductors. The current is generated at 110 volts pressure and two dynamos are connected in series for the purpose of supplying the outside line. This receives current at 220 volts pressure in consequence, but it has the added peculiarity of having three wires, between each two of which, that is to say, the first and second and the second and third, a dynamo is placed. Motors are fed from the two outer wires, which supply 220 volts, and lights are lit between the others. The insulations as well as the installation of continuous-current lines is not in any respect complicated. There are several methods of conveying the current in actual use. But before this department of the work is considered, the fact that the wiring of a building and the system employed in having it reach the building are entirely dissimilar in certain cases may be realized.

Subways are used for the transmission of current from the station to the building. Upon reaching the house the paths the current enters into are those which lead to motors and lights. Usually the subway systems are made of iron pipes ending at the corners in manholes, bricked carefully and othewise protected from the drainage of the neighborhood.

Both the alternating and continuous-current people employ this system of pipe conduits, although in the case of the Edison Illuminating Company, where continuous current is used, the use of three wires introduces a feature which has made this system valuable to all large cities.

Balancing the Load.—On account of the fact that three wires are used, the lighting occurs between either the first and second or the second and third wires. The general practice followed out by the Edison Illuminating Company is that of balancing the lamp load between these three in equal portions.

If 100 lamps are used between the first and the middle wire, to balance the line 100 lamps or their equivalent must be placed between the middle and third wire. The details of this system are quite interesting, as they exemplify the development produced by any departure from the ordinary in the pursuit of an improved method of distribution.

The Edison Company call the middle wire the neutral wire, because it is connected to both a positive and negative wire.

Advantages.—Some of the advantages of this Edison network lies in its reduction of the drop of potential to almost a minimum and the saving of a fourth wire. Also in the employment of two pressures convenient for both motors and lamps. There are certain excellent points in the application of this system alike to both street and house, which have given it a permanent hold on the public.

The Edison network is built in such a manner that centres of distribution are supplied with wires which indicate at the station the exact pressure at that point. Each junction of conductors is kept at the same potential, as far as possible, as every other. The immense system of wires enables them to preserve an almost equable pressure at all times. It is worth noting that if the pressure supplied to the feeders running along the streets is 240 volts, the drop occurring in the line can be so limited that at least 230 is

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left. This will be sufficiently high to enable us to wire a building and still have a working pressure of 220 volts in the house.

The problem of distribution consists in the preservation of the pressure at given points and not in the maintenance of it at a fixed pressure throughout. A station generating 100 volts may expect to lose 25 volts in the subway distribution, but it will be necessary for them to preserve the potential at the centres radiating to houses at a fixed value. If the allowance thus intentionally lost is premeditated, the new points in the street service from which the current is fed into the houses will remain at a constant pressure provided means are taken to effect the same. The value of a system depends upon the percentage of change going on; the less this is, the more life the lamps will have burned in its circuits.

The distribution of alternating current could in certain respects be carried on the same as by continuous. The high-pressure wires at 2,000 volts could lead to centres in the streets at which transformers could be placed and thus used as centres of distribution. The reduction of pressure from 2,000 volts need not be carried out in this case to less than 100 volts, and in this respect approach in technical detail the appearance of an Edison network as regards the centres of pressure and the wiring of the building.

QUESTIONS FOR REVIEW.

(1) What is meant by transmission of power?

(2) How do continuous and alternating currents differ?

(3) What is the general scheme of high-pressure alternating current transmission and distribution?

(4) Why do the Edison Illuminating Co. use a network of wires?

(5) State the problem of distribution?

INSULATION AND CONDUCTION.

(Continued from page 187.)

The idea that electrical flow in solid conductors might also be a simple handing on from one atom to another suggested itself nearly a decade ago to Prof. Lodge. That brilliant and careful reasoner and experimenter, who has cleared up so many patches of scientific jungle, gives a very clear description of the manner in which this would happen if such were the case. I cannot do better than quote him, as it will show how well this idea agrees with all the facts then known, but one.

"But if we are not satisfied with this vague analogy, and wish to penetrate into the ultimate nature of heat and the mode in which it can be generated, then we can return to the consideration of a multitude of oscillating and colliding particles, moving with a certain average energy, which determines what we call the temperature of the body. If now one or more of these bodies receives a knock, the energy of the blow is speedily shared among all the others; and they all begin to move rather more energetically than before: the body which the assemblage of particles constitutes is said to have 'risen in temperature.' This illustrates the production of heat by a blow or other mechanical means. But now, instead of striking one of the balls, give it an electric charge; or, better still, put within its reach a constant reservoir of electricity from which it can receive a charge every time it strikes it, and at the same time put within reach of some other of the assemblage of particles another reservoir of infinite capacity which shall be able to drain away all the electricity it may receive. In practice there is no need of infinite reservoirs; all that is wanted is to connect two finite reservoirs, or 'electrodes,' as one might now call them, with some constant means of propelling electricity from one to the other, i. e., with the poles of a voltaic battery or a Holtz machine.

"What will be the result of thus passing a series of electric charges through the assemblage of particles? Plainly, the act of receiving a charge and passing it on will tend to increase the original motion of each particle; it will tend to raise the temperature of the body. In this way, therefore, it is possible to picture the mode in which an electric current generates heat.

"But, although this process may be used as a possible analogy, it cannot be a true and complete statement of what occurs; for it is essentially the mode of propagation of sound. Sound travels at a known and definite velocity, being a mechanical disturbance handed on from particle to particle in the manner described. But heat, being some mode of motion, must also be handed on after some analogous fashion, so that when heat is supplied to one point of a mass it spreads or diffuses through it. It is difficult to suppose the conduction of heat to be other than the handing on of molecular quiverings from one to another, and yet it takes place according to laws altogether different from those of the propagation of the gross disturbance called sound. The exact mode of conduction of heat is unknown, but, whatever it is, it can hardly be doubted that the conduction of electricity through metals is not very unlike it, for the two processes are the same laws of propagation: they are both of the nature of a diffusion, they both obey Ohm's law, and a metal which conducts heat well, conducts electricity well also."

I have said, "with all the facts then known but one." This because, as mentioned in the abstract given above, there seemed to be no good evidence for the view that there was any connection between the conduction of sound and of electricity. The reason for this lay in the fact that very few determinations had been made of the velocity of sound in the pure metals, though a considerable number had been made on alloys and commercial materials. †

Consequently, no general law could be discovered, though it cannot be doubted but that had the formula for the relation between Young's modulus and atomic volume discovered by the writer ‡ been known at that time this evidence of a still more intimate connection between sound, heat and electricity would have been discovered by Dr. Lodge.

The formula referred to is:

$$\text{Young's Modulus} = \frac{78 \times 10^{12}}{(\text{atom. vol.})^2}$$

Hence it is possible to predetermine the velocity of sound in wires by the formula:

$$\text{Velocity in cms. per sec.} = \frac{833 \times 10^4}{\text{atom. vol.} \times \sqrt{\text{density}}}$$

and the electric resistivity is given roughly by:

$$\text{Resistivity} = 45 \times 10^{-9} \times \text{atom. vol.} \times \sqrt{\text{density}} \times \text{valency}$$

This formula possesses a general interest, inasmuch as it would seem that while the strain in the dielectric is propagated with the velocity of light, i. e., $\sqrt{k\mu}$, the actual electricity in the wire were handed on with the velocity of sound and is proportional to

$\sqrt{\frac{k}{\mu}}$ The significance of this will be treated of elsewhere.

DEVELOPMENT OF ELECTRICAL SCIENCE

to be continued next week.

Orillia, Ont.—The town council has still under consideration the question of obtaining power from the Ragged Falls. It is estimated that the necessary electrical plant for developing 1,500 horse-power and transmitting it 15 miles would cost from $60,000 to $75,000.

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CHAS. W. HOLTZER, president of Holtzer-Cabot Electric Co., of Brookline, Mass., was in town this week.

JOHN C. GRANT, representing the Holtzer-Cabot Electric Co., Boston, Mass., and 112 Liberty street, New York, was in town, looking after the interests of his company.

NEW ELECTRICAL CORPORATIONS AND BUSINESS CHANGES.

Glens Falls, N. Y.—The Glens Falls, Sandy Hill and Fort Edward Electric Railroad Co. will erect a new power-house.

Stuttgart, Ark.—The Stuttgart Water & Electric Co. will assume the franchise granted to Charles Williamson, and arrange for the construction of plants and lighting and water supply.

McComb, Miss.—An electric-light plant will be established.

West Plains, Mo.—The West Plains Telephone Co. has been incorporated by D. W. Reese, Charles H. Gale, F. O. Hines and others. Capital stock, $20,000.

Canadian, Tex.—The Canadian & Cheyenne Telephone Co. has been incorporated by George Gerlach, Robert Moody and D. J. Young. Capital stock, $2,500.

Grafton, W. Va.—The Wickwire Telephone Co. has been organized with Dr. Alex. Leeds, president; Richard Wood, vice-president; Z. B. Knotts, secretary, and Edward Luzatter, general superintendent, and is constructing its lines.

NEW YORK NOTES.

PARAGON NEW POWER MOTORS, of 39 Cortlandt street, now running the big exhibit of eleven bicycles, all operated by figures of noted riders, are shown in one of the windows of H. C. F. Koch & Company, 125th street, west, N. Y. This exhibit is made in commemoration of the opening of bicycle department.

WIDESPREAD INTEREST IN ELECTRICAL EXHIBITIONS.—The interest taken in Electrical Exhibitions is by no means limited to Greater New York, but extends in every direction. Numerous comments have been made by the foreign press, and by journals in different parts of the country. Prof. R. B. Owens, director-general of the electrical work at the Omaha Exposition, beginning in June, has been specially instructed to visit this city in May and acquaint himself with the exhibits and the work being done. Many inquiries have come from foreign managers and manufacturers, as to the time and nature of the exhibition, and it is a fact beyond question that a stimulus will be given to export trade. As was the case at the exhibition in 1896, many of the exhibits will go straight from the floor to foreign countries.

M'CULLAGH POLICE SIGNALLING SYSTEM.—One of the universal complaints in regard to a policeman is that you can never find him when he is wanted. Chief McCullagh, the head of the police force of Greater New York, has studied this problem intimately, and has evolved a system of communication which marks a new departure in the police supervision of any large community. He proposes to establish a certain number of policemen at stated points all over the city, connecting their booths or sentry boxes by telephone with the police station of the precinct. No matter what happens, any one who wants the help of the police can go at once to these well-known points and obtain the service of the officer there, he, in turn, notifying his headquarters of the call and securing a relay, in the shape of one officer or a dozen, as the case may need. It will be obvious that such a system not only gives instantaneous police help, but by establishing a series of trochas, makes it very hard for a fugitive criminal to break through, as he is liable to interception in whichever direction he goes. Chief McCullagh has kindly promised to have on exhibition at the Garden in May, one of those novel and interesting booths, which, in the course of a few years, will doubtless stud the sidewalks of all our great cities.

WRITER MADE A VISIT to our sister city of Newark, N. J., and found the Backus Water Motor Company very busy preparing their electric ceiling fans for the spring trade.

GEO. ZIMMERMAN, of Market street, the electrical specialist contractor, is actively engaged on some very unique and difficult electrical installments. He carries the largest stock of fine goods for interior electric light effects and call systems.

HANSON-VAN WINKLE COMPANY, the world-famous electro-platers, dynamo specialty outfitters, make preparations to flood the market with a new catalogue which they have under way.

THE EASTERN ELECTRICAL SUPPLY CO., of 26 Cortlandt street, N. Y., have a fine supply house on Market street, Newark, and the electricians of Newark are finding it a very convenient place to get everything they need.

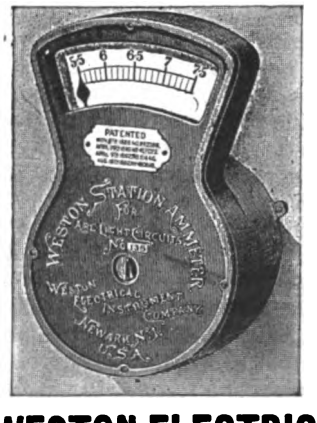
STUCKY & HECK, of 35 N. J. R. R. avenue, are the largest manufacturers of electric goods and specialties. The repairing and reconstruction of electric railway and power motors and dynamos, rewinding of armatures and refilling of commutators form a great part of their industry. They will make up stock orders from models as standard supplies at the best attainable rates.

C. M. McINTIRE CO., 15 Frauklin street, are actively engaged filling big orders received daily from Mr. McIntire on the road. Their McIntire patent commutators and terminals, fuse wire, fuse links and strips are growing in demand every season.

GOULD & EBERHARDS, the big machine tool makers, were shipping a big order to Austria and France when writer called. They are doing a big export trade.

J. JONES & SON, 67 Cortlandt street, N. Y., one of the most popular supply houses in this section, have secured the whole building at 64 Cortlandt street. The main floor will be fitted as a model supply store, and you will get just what you want at the right price. Their works in Brooklyn are kept busy in making their special electric light and power switches, switchboards, panel boards, etc. W. T. H.

Welland, Ont.—The Welland Aqueduct Power Company has been organized with a capital of $25,000 to supply electricity for light, heat and power.



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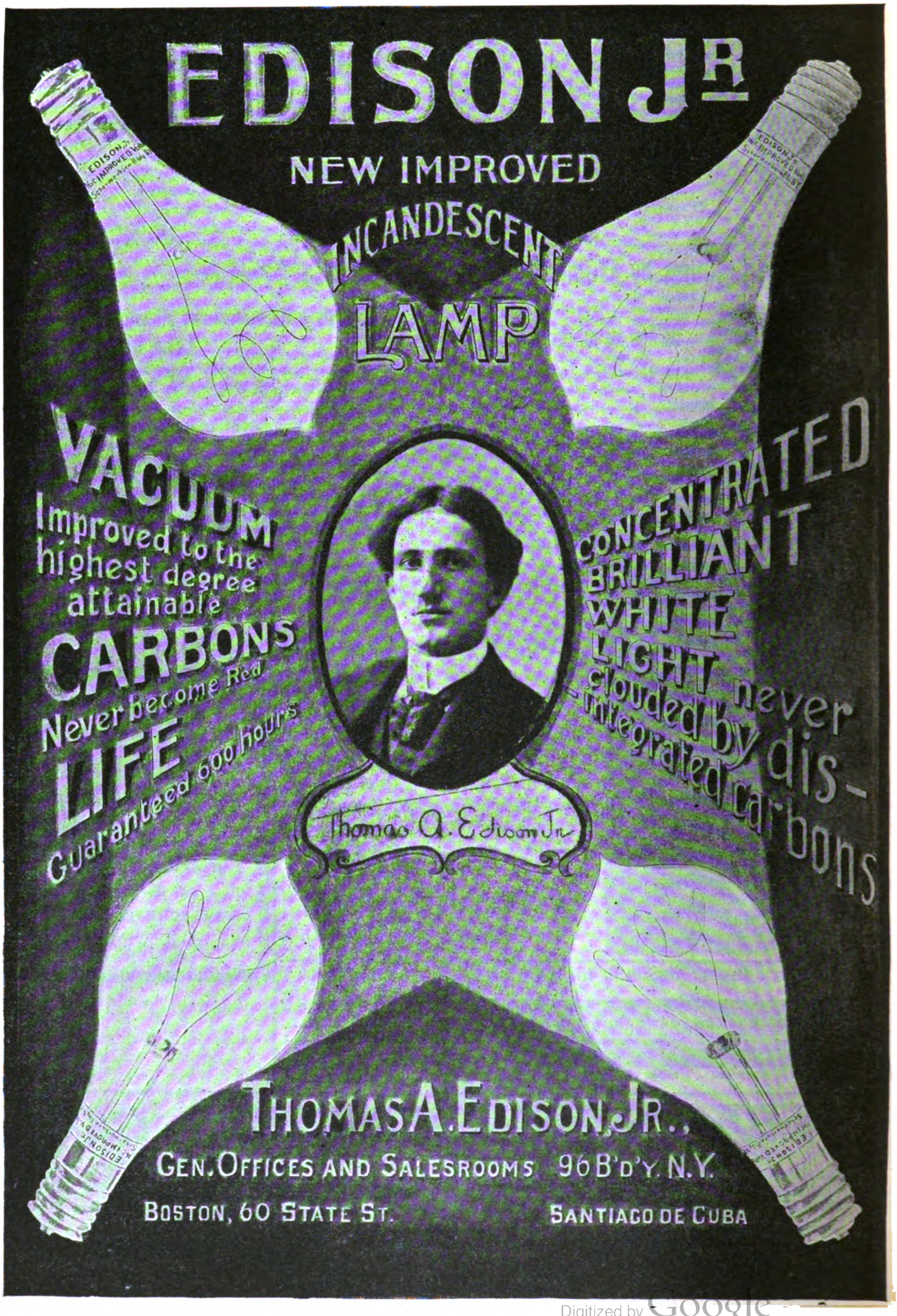

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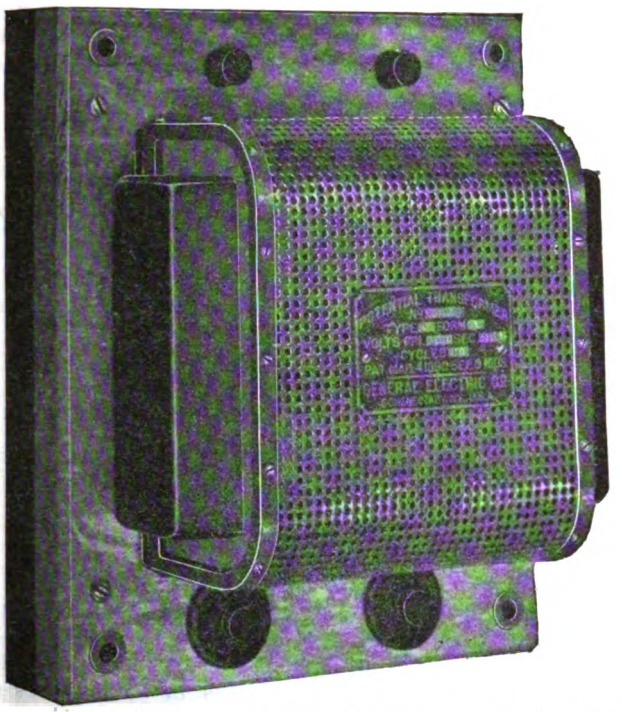
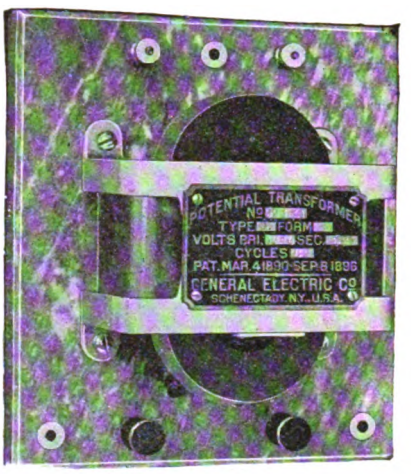
ILLINOIS ELECTRIC CO., 239 Madison St., Chicago Agents.

The Electrical Age.

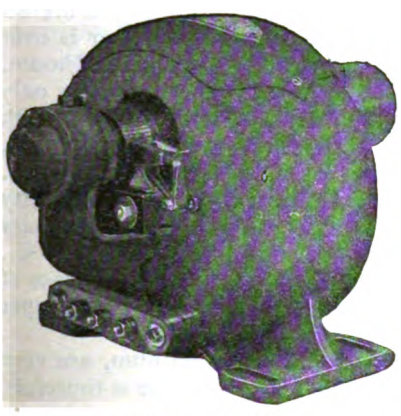
VOL. XXI—No. 16 NEW YORK, APRIL 16, 1898 WHOLE NO. 570



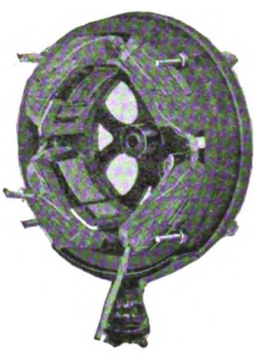
New G. E. Transformer. 1040 Volts Primary, 52 Volts Secondary, 60 to 25 Cycles.



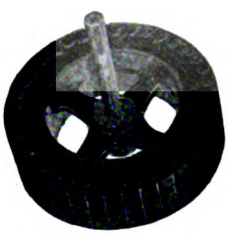
G. E. Transformer. 1040 Volts or 2080 Volts, 60 to 125 Cycles.



G. E. Monocycle Motor.



Field.



Armature.

Bearing.

A NEW POTENTIAL TRANSFORMER.

To meet various conditions the General Electric Company has designed five different potential transformers. The first wound for 1,040 volts primary and 52 volts secondary, for frequencies 60 to 125 cycles, is intended for use on circuits, the voltage of which does not exceed 1,250 volts, to supply current to indicating voltmeters reading to 75 volts and to primary recording wattmeters.

The second, wound for 1,040 or 2,084 volts primary and 52 or 104 volts secondary, for frequencies of 60 to 125 cycles, furnishes current for indicating voltmeters reading to 75 or 150 volts, and is so wound that coupling the coils differently for use on different voltages is unnecessary. It has ample carrying capacity in the winding to give its full output on the lower voltages when only one-half of the winding is in use. Three primary and three secondary terminals are provided. If the transformer is used on 2,080-volts circuits, the two outside primary terminals are connected to the line. If, however, it is used on 1,040-volt circuits, the middle terminal and either outside terminal are connected to the line. By making similar connections on the secondary side either 52 or 104 volts can be obtained.

The third, wound for either 1,040 or 2,080 volts primary and 57½ or 115 volts secondary, for frequencies of 60 to 125 cycles, is identical in its construction and use with the second, except that it is wound for stations using a ratio of transformation of 1 to 9 or 1 to 13 in place of 1 to 10 or 1 to 20.

The fourth is so designed that it can be wound for any primary voltage up to 6,000 volts and any secondary

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voltage up to 115 volts, for frequencies between 60 and 125 cycles. As parts of this transformer are kept in stock, it can be wound on short notice.

The fifth is similar to that just described, but slightly larger. It can be wound for the same voltages, but has a range of frequency from 25 to 60 cycles.

These transformers are designed to supersede all station and meter transformers which have been built by the General Electric Company up to the present time.

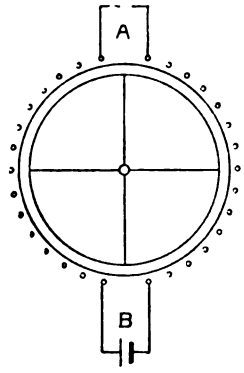

Fig. 2.

INSULATION AND CONDUCTION.

(Continued from page 207.)

Suppose a wheel, with elastic spokes and a heavy rim bound outside with a band of horsehair. the horsehair rubbing against a series of violin strings mounted parallel to the axis of the wheel, as shown in Fig. 2. Suppose each violin string has mounted upon it a small metallic bead charged with electricity, so that when the strings vibrate the beads can touch. Then on grasping the wheel at B, after a time depending upon the elasticity and mass of the wheel, a spark will be seen at A, but the actual velocity with which the electricity moves round the circuit of violin strings will depend upon the elasticity and mass of the strings. In passing, we may note several things :

1st. That for this analogy to hold good at all, the atoms must be charged even in a conductor not carrying current; which is significant when taken in connection with the fact pointed out by the writer in the papers above referred to, that if we calculate the tensile strength, rigidity and Young's modulus on the assumption that these effects are due to charges on the atoms, we get results agreeing very closely with experiment.

2nd. That in a circuit having many atoms in the cross-section the energy could be handed on without actual contact by electro-dynamic process.

3d. That if one part of the circuit were composed of violin strings tuned to a different note-period from the other, we would get effects similar to those of thermo-electricity. §

4th. That the reversal of the point of greatest drop of potential in a circuit of air and carbon from the + to the — electrode as the pressure is reduced may be due to the fact that, as shown by the beautiful experiments of J. J. Thomson, the molecular conductivity of air at low pressures is extremely high, the electrode heated thus depending upon whether the solid conducts better than the gas, or vice versa.

5th. That this same formula would also be applicable to a diffusion phenomenon, and indeed the presence of valency in the formula makes it exactly analogous to that for the diffusion of heat. Moreover, Roberts-Austen, in a series of striking experiments, has shown that diffusion can take place in solids at ordinary temperatures. If a current be, however, a diffusion, it may be shown that for fairly large current densities the atoms must move several cms. per second, and we might therefore expect interpenetration when brass and zinc terminals are joined. But this does not occur to any considerable extent. We may also take it as an electrolytic diffusion, as is suggested by J. J. Thomson, in his "Dynamics Applied to Physics and Chemisty," but in this case, even assuming the theory suggested by him to account for some atoms preferring a plus to a negative charge, I find it difficult to imagine the manner in which the atoms could be charged and discharged at the surface of the conductor. It is to noted that in gases the phenomenon of diffusion, sound velocity and heat conductivity are all linked together.

It will be noticed that in the table given, while the metals follow each other in the order they should from calculation, yet the agreement is in some cases not so close as in others. This may arise from several causes :— 1. The conductivities of but few of the metals are accurately known. 2. The elasticities of but few of the metals are accurately known, and the formula given for the Young's modulus only roughly takes temperature into account. 3. The temperature coefficients of the metals are not the same. For instance, that for copper is over .4 : .415, having been obtained by Swan and Rhodin, and .404 by Kennelly and the writer, whilst silver is only .38 and gold .36. Consequently, the ratio will vary with the temperature, and at higher temperatures the ratio, resistivity of copper : resistivity of silver will be less. This, it is interesting to note, holds true for the velocity of sound, for from Wertheim's results we have, velocity of sound in silver : velocity in copper = 1.35 at 20° C., and only 1.19 at 200° C., and hence, just as in the case of electrical conductivity, the sound conductivity of copper diminishes at a faster rate than that of silver.

The magnetic metals, as iron and platinum, are very difficult to obtain pure. Their true resistance is therefore at present doubtful.

What has been mentioned thus far concerning the resistance of solids has had no immediate bearing on the subject of insulation. It was necessary, however, in order to introduce the following considerations.

(To be continued.)

† I am here moved to again call attention to the fact that an immense amount of physical experimental work is misdirected. It is no doubt quite gratifying to ascertain, after several years' laborious work, that a particular piece of brass or steel of not very definitely known composition and in a quite indefinite physical state has a temperature coefficient of expansion expressed by five significant figures, but such information must be considered as pieces of philosophic virtu, intrinsically worthless, but possibly possessing a value by reason of their uniqueness and associations. I have pointed out elsewhere (Jour. Frank. Inst.) that at the present time, in spite of the fact that much has been done, notably by Matthiessen, Roberts-Austen and others, we have not at present any data in regard to 90 per cent. of the more important properties of the simpler metals used in the arts. The importance of having a standard state for solids; of a central bureau to furnish pure materials in a standard physical state to experimenters, and the exclusive use of such materials by experimenters, cannot be overestimated.

‡ Elec. World, Aug. 22, 1891; Science, July 22, 1892.

§ Compare the analogous problem of two portions of gas of different densities in a closed ring tube, and junctions heated. Neuman, Jahrberichte f. Chem., 1874, p. 15.

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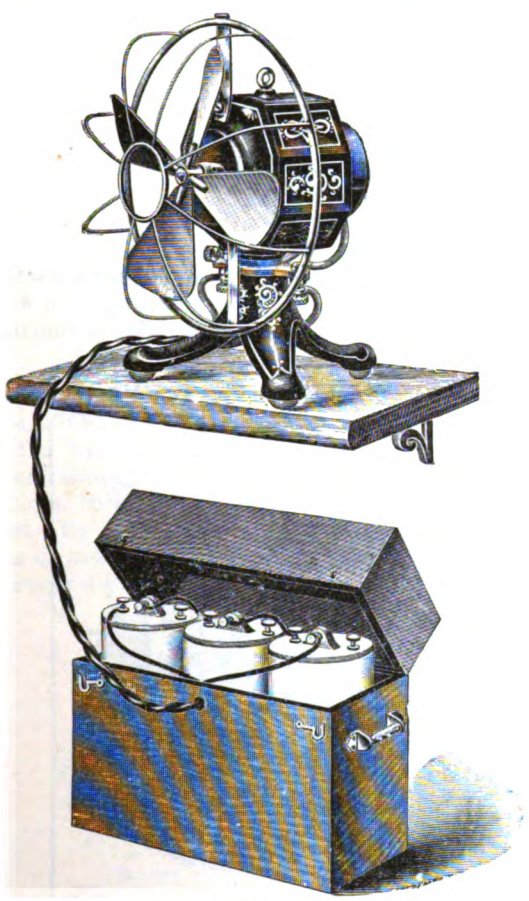
THE NEW EDISON FAN MOTORS.

The problem of designing a fan motor which will give good ventilation and run economically by battery power is one that has engaged the serious attention of the whole electrical world, and we are pleased to be able to record some very great advances which have recently been made in this direction.

The Edison Manufacturing Co., of New York and Orange, N. J., are about to place on the market a battery fan outfit, which is greatly superior to anything that has been produced up to the present time. The 9-inch battery fan outfit, manufactured by this concern, deserves special notice.

The motor is of the Paccinoti ring type, and runs on ball bearings. A series of most elaborate tests, extending over several months, were made before this innovation was finally decided upon, and the results obtained fully justify the change which has been made. When this outfit was first placed on the market, some five years ago, the motor had a 6-pole armature and a battery consisting of 4 Edison-Lalande cells, type "S," in oak box, which ran the motor for 100 fan hours at a speed of about 700 r. p. m. before needing to be renewed.

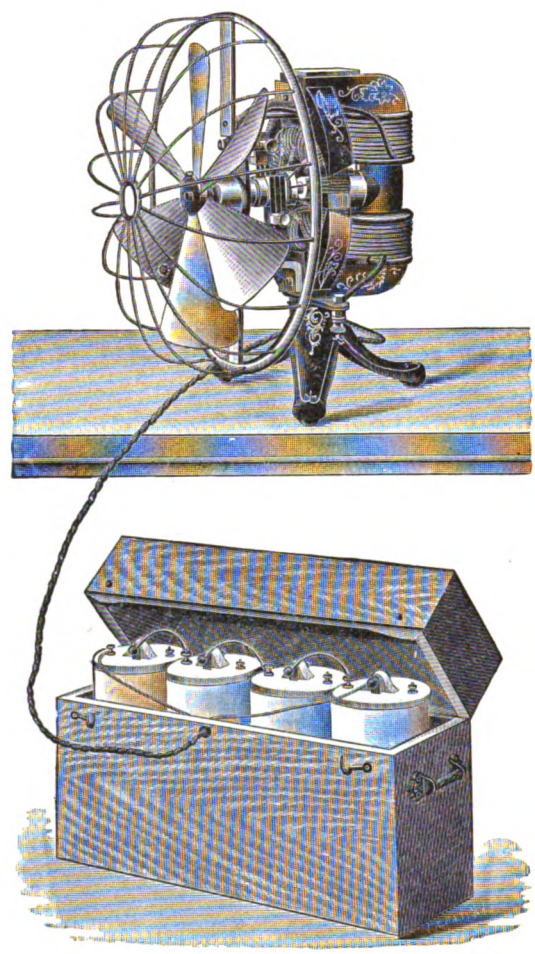


Three Cell Battery Outfit.

In the spring of 1897 a new motor was designed, having a Paccinoti ring armature, which was considerably more efficient than the old-style motor, as the working current was reduced so that the battery would last for 125 fan hours, and the speed of the fan was increased to about 800 r. p. m.

The new ball-bearing motor, which is now furnished with this outfit, takes only 1.75 amperes of current, and runs fan upwards of 850 r. p. m. As the capacity of the battery is 300 ampere hours, it follows that it will run the fan for 170 fan hours before needing renewal. It will thus be seen that the efficiency of the new motor in saving of battery power is 33⅓ per cent. over that of the 1897 model, and 70 per cent. over that of the original model, which is a most satisfactory showing. This does not take into account the increase in speed of the fan from 700 r. p. m. to 850 r. p. m., which is even more remarkable. (See Fig. 1.)

The Edison iron-clad battery fan outfit, manufactured by the same concern, has also been greatly improved. The motor, which carries a 7-inch fan and is furnished with 3 Edison-Lalande cells, type "S" (300 ampere hour capacity), in oak box, has been greatly simplified in construction. The improvement consists in the substitution of a small drum commutator for the disk commutator, formerly used in this motor, and the extension of the rear shaft support (carrying the brushes) beyond the iron-clad field, so as to enable the brushes to be easily adjusted. The motor runs the fan at 1,200 r. p. m., and the battery will last for 150 fan hours before being exhausted. (Fig. 2.)



Four Cell Battery Outfit.

The great success that has attended the exploiting of both these battery fan outfits has induced the Edison Manufacturing Co. to enter the field of the 110-volt direct-current fan motors, and they are now placing on the market a very satisfactory fan motor for this current, furnished with 12-inch fan and guard. (Fig. 3.) This motor is similar in construction to the 9-inch Edison battery fan motor, but is furnished with a 3-speed switch, running the fan at 1,000, 1,200 and 1,400 r. p. m. respectively. The efficiency of this instrument is very high, and the workmanship of all the outfits is of the very first grade.

Baltimore, Md.—The Heat, Light and Power Company has been incorporated by Joseph P. Smith, Bertram S. Morrill, John W. Kaiser, Bernard T. Warthen, and Theodore E. Dollard, to construct and operate overhead wires for illuminating purposes, and to furnish motive power for machinery and such other purposes as electricity may be used. Capital stock $10,000.

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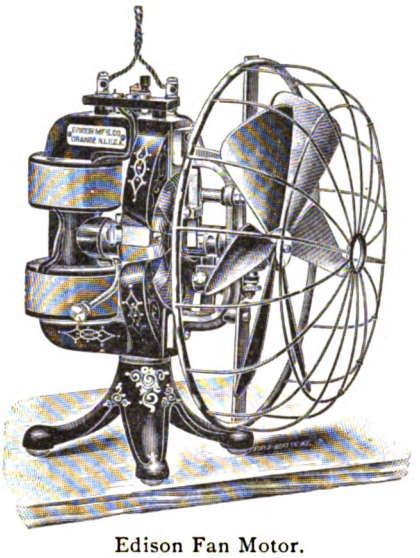
THE BACKUS ELECTRIC VENTILATING FAN.

One of the oldest concerns engaged in the manufacture of electric fans is the Backus Water Motor Co., of Newark, N. J. The fans manufactured by the above require no attention, use very little current, and combine mechanical perfection with a handsome appearance. The 1898 fan and ventilating outfits leave but little to be desired either in the pressure blower proper, ceiling or column fans.



Edison Fan Motor.

The ventilating fans operate with two speeds when desired and require no attention after installation. There are no copper brushes to wear out and no oil to drip. The ceiling fans are supplied with or without switch, are finished with polished brass basket and crown, and highly ornamented stem and blade holder. The use of a switch at the bottom of the fan saves extra wiring. Other fans supplied with electric light represent a useful, practical and highly ornamental combination. In winter the blades may be removed and the chandelier remain. The column fans, constructed with hooks and umbrella stands, have become very popular in high-class dining-rooms. They are finished in brass, nickel, oxydized silver, old gold or ivory, and look very beautiful when in-

Backus Factory.

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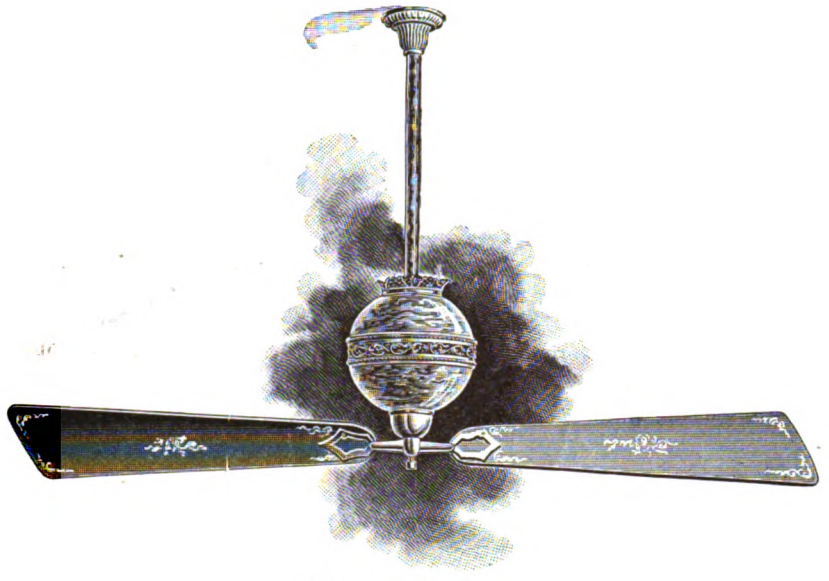
stalled. The motor and pressure blower combination require but a minimum of attention. The blades deliver air without loss of any consequence, and the motor does not heat or spark. The remarkable superiority of the Backus outfit can be attested to by all customers. The simplicity of construction and excellence of appearance have always secured for Backus ventilating apparatus a ready sale.



Backus Ceiling Fan.

PROPOSALS FOR ELECTRIC LIGHTING.—Sealed proposals will be received until 12 o'clock, noon, May 10, 1898, for the lighting of the streets of the borough of Mechanicsburg, Cumberland county, Pa., by electricity, as follows, to wit :

First—By 47 or more arc lights, 1,600 candle power, and 12 or more incandescent lights of 32 candle power to burn every night and all night.

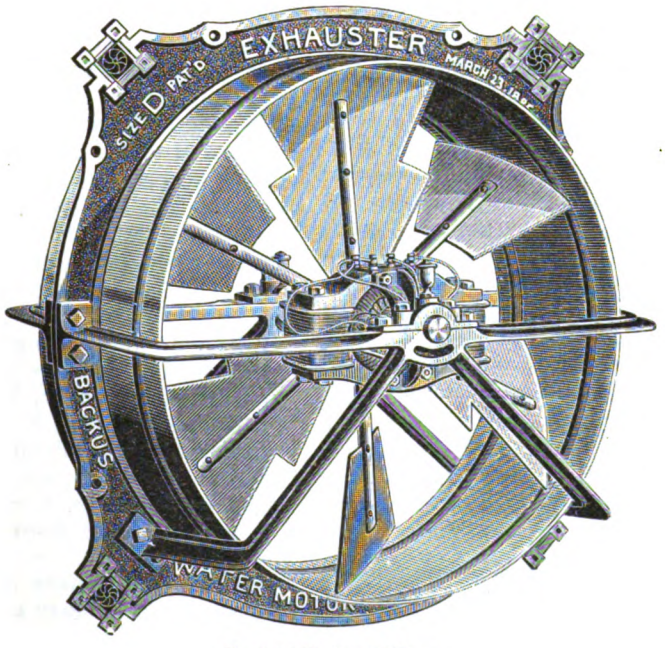
Second—By 47 or more arc lights, 1,600 candle power, and 12 or more incandescent lights of 32 candle power to burn every night until 12 o'clock.

Both bids to be on a one-year contract, allowing the borough the privilege of renewing contract annually for two years additional.

Bids in all cases to give price per light per year. The lights to be of the most modern and approved construction. The plant to be erected and maintained with duplicate machinery, under the borough franchise for public and commercial light, heat and power, and to be of sufficient power to permit the use of additional arc or incandescent lights as may be required by the borough from time to time, at same or less price than that named in the original contract, the poles, wires and lights to be located and erected under the direction of the borough council.

Bidders to name place plant is to be located. If not in borough of Mechanicsburg, Pa., where?

The successful bidder will be required to give a satisfactory bond as a guarantee that the plant will be put into operation by September 1, 1898, if one should be made under this proposal, and that the same will be maintained and operated during the full term of the contract.



Backus Exhaust Fan.

The borough reserves the right to reject any and all bids. Proposals to be marked "Bids for Electric Lights," and addressed to

C. N. Owen,
Chairman Light Committee,
Mechanicsburg, Pa.

Markham, Ont.—Steps have been taken by the village to rebuild the water-works and electric light plant.

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LIQUID AIR.

At the March meeting of the Franklin Institute, Philadelphia, Mr. Chas. E. Tripler, of New York, made an interesting demonstration of some of the properties of liquid air. The fluid is, of course, intensely cold. It is of a milky white color when exposed to ordinary air, and in ordinary temperature it keeps up a continuous boiling. Touched by the hand it gives the very peculiar sensation of being a "dry liquid," and unless the hand is held in the liquid for a little time no moisture clings to it, and the only sensation is one of intense cold. The odor of the liquid air is peculiar.

The effect of the fluid on various substances is curious. Rubber, eggs, onions, oranges, beef-steak, iron and tin-plate were rendered very brittle by being immersed in it, and the speaker performed many very curious experiments with these substances. Mercury is rendered very hard, having a tensile strength while under the influence of the liquid air about equal to that of cast-iron under ordinary conditions. A hammer made of mercury treated with the liquid was used to drive nails through a board, and a bar of mercury treated in a similar manner held in suspension a fifty-six-pound weight for a period of twenty minutes before the threads about the screw-eyes in either end of the bar melted sufficiently for the screw-eyes to pull out. Gold, silver and other of the higher metals were unaffected by the material, and leather and some other substances showed no radical change.

Cotton waste, Mr. Tripler explained, when soaked with the liquid and fired with a match, develops an explosive power greater than gun-cotton, and small pieces of copper pipe and steel bicycle tubing were shown in which cotton so treated had been placed without packing. Both were split and torn as if they had been simply pasteboard.

As to the practical uses of the substance, only suggestions can yet be made. The high explosive power of cotton treated by the liquid suggests one use. Its intense cold, its temperature being about —191 degrees C., suggests its use as a refrigerating agency. Mr. Tripler suggested its possible application as a power developer by showing that water poured into a tea-kettle partly full of the liquid caused an evolution of power apparently as great as would be given off by a pot of boiling water. One of the most important uses of the liquid, it is expected, will result from the fact that metals treated with it offer practically no resistance to electricity, and as a result it is claimed that by treating dynamos their power can be enormously increased. Prof. Elihu Thomson, of Schenectady, is now experimenting with the liquid used for this purpose. Mr. Tripler is still working on experiments in the liquefication of gases, and he predicts that the liquefication of hydrogen in appreciable quantities is only a matter of patient application, although he expressed some doubt as to what the actual accomplishment of that feat would be except as a scientific triumph.

SECOND ELECTRICAL AND KINDRED INDUSTRIES EXPOSITION.

The above exposition is to be held at Madison Square Garden, under the auspices of the New York Electrical Society, from May 2nd to May 31st, 1898. The management of the Electrical Exhibition Company, conducting the Second Electrical and Kindred Industries Exposition, is determined that even though further complications with Spain should arise, the holding of the exposition will not be interfered with in any respect, as the enclosed list of exhibitors guarantees a splendid show. The following list of exhibitors will show how great an interest has already been awakened in the coming exposition by many of the most prominent manufacturers in the United States:

REVISED PARTIAL LIST OF EXHIBITORS.

Armorite Interior Conduit Co., Pittsburg, Pa.
American Rheostat Co., Milwaukee, Wis.
American Pulley Co., Philadelphia, Pa.
American Watchman's Time Detector, 234 Broadway, N. Y.
American Engine Co., Bound Brook, N. J.
Adams-Bagnall Electric Co., Cleveland, Ohio.
Armington & Sims Co., Providence, R. I.
American Electrical and Maintenance Co., 451 Greenwich street, N. Y.
American Electrician Co., New York.
American Electrical Works, Providence, R. I.
American Electric Novelty and Manufacturing Co., 231 Broadway, N. Y.
American Circular Loom Co., Boston, Mass.
Bullock Electric Co., St. Paul Building, N. Y.
Bossert Electric Construction Co., Utica, N. Y.
Baylis Co., The, 99 Cedar street, N. Y.
Borne, Scrymser Co., 80 South street, N. Y.
Belknap Motor Co., Portland, Me.
Brewster Engineering Co., 27 Thames street. N. Y.
Barrows & Co., C. H., 302 West 53d street, N. Y. (Electric Vehicles.)
Broomell, Schmidt & Co., York, Pa.
Boston Electro Duct Co., Boston, Mass.
Burhorn & Granger, 136 Liberty street, N. Y. (Woodbury Engines.)
Babcock & Wilcox Co., 29 Cortlandt street, N. Y.
Crocker-Wheeler Electric Co., 39 Cortlandt street, N. Y.
C. & C. Electric Co., 143 Liberty street, N. Y.
Corey, R. B., 26 Cortlandt street, N. Y.
Coho & Co., H. B., 220 Broadway, N. Y.
Card Electric Co., Mansfield, Ohio.
Camp Co., H. B., Aultman, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Crouse-Tremaine Carbon Co., Fostoria, Ohio.
Crown Woven Wire Brush Co., Salem, Mass.
Cook's Sons, Adam, 313 West street, N. Y.
Cutter Electrical and Manufacturing Co., Philadelphia, Pa.
De La Vergne Refrigerating Machine Co., 138th street and East River, N. Y. (Hornsby-Akroyd Oil Engine.)
Diamond Electric Co., Peoria, Ill.
Diesel Motor Co. of America, 11 Broadway, N. Y.
Edison, Thomas A., Orange, N. J.
Edison Electric Illuminating Co. of N. Y., Duane and Elm streets, N. Y.
Eddy Electric Manufacturing Co., Windsor, Conn.
Electric Storage Battery Co., Philadelphia, Pa.
Excelsior Electric Co., Brooklyn, N. Y.
Edison Manufacturing Co., Orange, N. J.
Edison, Jr., Thomas A., 96 Broadway, N. Y.
Electrical Engineer, New York.
Electrical Review, New York.
Electrical Age Publishing Co., New York.
Electricity Newspaper Co., New York.
Electrical World, New York.
Elliott & Hatch Book Typewriter Co., 253 Broadway, N. Y.
Electrical Engineer Institute of Correspondence Instruction, 120 Liberty street, N. Y.
Fischer Foundry & Machine Co, Pittsburg, Pa.
Fort Wayne Elec. Corporation, Fort Wayne, Ind.
Fuel Economizer Co., Matteawan, N. Y.
Fostoria Incandescent Lamp Co., Fostoria, Ohio.
Fiberite Co., Mechanicsville, N. Y.
Fairchild & Sumner, 39 Cortlandt street, N. Y.
Francis Bros., Philadelphia, Pa.
Gold Car-Heating Co., Cliff & Frankfort streets, N. Y.
Garton-Daniells Electric Co., Keokuk, Ia.
Garvin Machine Co., Spring & Varick streets, N. Y.

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MAGNETIC BLOW OUTS.

Many interesting inventions have come into existence which make use of a device for blowing out the electric arc. One of the most interesting experiments that can be tried with simple apparatus is the blowing out of an arc by means of a magnet. If two carbons between which an arc has been started be utilized for demonstratiug this phenomenon, and a strong electro-magnet brought near the source of illumination, the arc will move away, lengthen out and finally disappear. The reason why an electric arc is affected by a magnetic field is simple enough. The arc represents part of a turn and develops magnetic polarity; the approaching electro-magnet necessarily affects it, repelling it and ultimately destroying its continuity.

The Thomson-Houston lightning arrester makes use of this principle in blowing out the arc which would be started by a flash of lightning. The curious case then occurs of an electrostatic charge leaping between two terminals, starting thereby an arc due to the current and pressure in the line. This arc would continue unless means were taken to destroy it. The influence of a powerful electro-magnet is therefore of the utmost practical value when serving merely in this capacity.

The Walker Company have constructed a solenoid blow-out controller in which the tearing and wasting of metal whenever circuits are opened is entirely obviated. Being built on scientific principles, care is taken to prevent the magnet from becoming saturated, so that the current about to be discontinued will, when circulating through the coils provided with the controller, effectively destroy the arc formed at the instant of separation. The lines of force proceeding from the solenoid emanate in straight lines, which affect the arc at once, the arc being forced away from the contact neither sideways nor forward, but as though it had been removed by invisible fingers directly away from the parting extremities. In controllers the sudden breaking of a circuit may cause destruction to the winding of either armature or field. It is necessary, therefore, to gradually reduce the current before breaking the circuit. The effect of the solenoid is to gradually lengthen the arc without any sudden detonation when it ceases.

Other cases might be cited in which the magnetic wind, as it is sometimes called, is made use of, but whenever such a case does occur it must be known that the purpose for which the magnet is used is a simple one—the destruction of an injurious arc.

THE LIQUEFACTION OF FLUORINE.

In 1670 Schwankhardt, of Nuremburg, discovered a liquid which possessed remarkable properties. The famous chemist, Scheele, remarked in 1771 that the discovery of Schwankhardt was that of fluorine. Moissan, the famous French chemist, produced fluorine in a free state by using a powerful current of electricity. Mr. C. F. Townsend, F. C. S., states in "London Knowledge," that in his opinion the liquid sought for as a universal solvent by the alchemists of past ages finds its nearest approach in liquid fluorine. If a piece of flint is placed within the vapor of fluorine it becomes a scintillating mass of incandescence. One of the few metals that will withstand its influence is platinum, and in its manufacture by M. Moissan the apparatus was constructed of the same.

For many years the gas fluorine was all that chemists could hope to experiment with, but since the invention of powerful machinery for producing liquefied air Professors Dewar and Moissan have succeeded in condensing the gas into pure liquid fluorine. The activity of this corrosive liquid will greatly diminish at a very low temperature, although its boiling point is 187 degrees below zero, Centigrade. This is almost the nearest approach to absolute zero reached by man. Prof. Moissan found it impossible to isolate fluorine from its combinations except by employing a current of electricity.

The liquefaction of fluorine is a wonderful achievement, involving the use of tremendous pressure, cold in comparison with which the North Pole would be a warm summer's day, and a current of electricity. Since mankind has learned to control and transform the forces at his command, experiments that will immortalize this age have been successfully conducted. Their usefulness from a commercial standpoint is not always apparent, but as a triumph Science will never cease speaking of them.

THE BROOKLYN POLYTECHNIC INSTITUTE

and Dr. Samuel Sheldon, its professor of physics and electrical engineering, have kindly loaned the Electrical Exhibition several interesting units and standards upon which precision in electrical measurements is based. Even the electric public, while it hears a great deal of such standards, rarely sees them, and this exhibit, therefore, will be at once of technical and popular interest. The exhibit will include, especially, some standards from the German Imperial Physico-Technical Institute (Reichsantalt), whose celebrated work has been done under the guidance of such men as Helmholtz and Kohlrausch; and it is probable that these standards have never before been exhibited in public in this country. Dr. Sheldon will show the Reichsantalt form of the standard Clark cell, the Reichsantalt pattern of photometer with Hefner Amyl-acetate standard lamp and Lummer Brodhun contrast screen, standard .01 ohm for carrying heavy currents, large standard compensation set for the precise comparison of voltages from .01 to 1,200 volts and currents of any magnitude, standard Wheatstone bridge, Thomson's double bridge for conductivity measurements, standard Carhart-Clark cell, etc. The exhibition of such apparatus and the explanation given as to its use will do much to bring electrical measurements within the comprehension of the public, and to demonstrate the wonderful refinement of accuracy that modern electricians aim at in their apparatus.

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General Incandescent Arc Light Co., 33d street and 1st avenue, N. Y.
Griffing Iron Co., A. A., Jersey City, N. J.
Harrison Safety Boiler Works, Germantown Junction, Philadelphia, Pa.
Highland Chemical Co., Connellsville, Pa.
Haines Co., Wm. S., Philadelphia, Pa.
Haring Steam Plant Equipment Co., 26 Cortlandt street, N. Y.
Hope Electric Appliance Co., Providence, R. I.
Ideal Electric Corporation, 13th & Hudson streets, N. Y.
Imperial Porcelain Works, Trenton, N. J.
India Rubber & Gutta Percha Insulating Co., Glenwood, N. Y.
International Arc Lamp Co., Mercer & Houston streets, N. Y.
Jones & Son, J., 69 Cortlandt street, N. Y.
Keuffel & Esser Co, 127 Fulton street, N. Y.
Kelley & Sons, B. F., 91 Liberty street, N. Y.
Keystone Electrical Instrument Co., 9th street and Montgomery avenue, Philadelphia, Pa.
Keiley & Mueller, 7 West 13th street, N. Y.
Kosmic Oil Filter Co., Easton, Pa.
K. & W. Co., Pittsfield, Mass.
Katzenstein & Co., L., 357 West street, N. Y.
Kensington Engine Works, Ltd., Philadelphia, Pa.
Kirkland, H. B., 120 Liberty street, N. Y.
Lewis Tool Co., 44 Barclay street, N. Y.
Lynn Incandescent Lamp Co., Lynn, Mass.
Morris, Elmer P., 15 Cortlandt street, N. Y.
Machado & Roller, 203 Broadway, N. Y.
Mowrey, P. M., & Co., 318 Broadway, N. Y.
Monarch Manufacturing Co., Waterbury, Conn.
Niles Tool Works, Hamilton, Ohio, and N. Y.
National Meter Co., 118 Chambers street, N. Y.
Nowotny Electric Co., Cincinnati, Ohio.
National Carbon Co., Cleveland, Ohio.
Nash Gas Engine Co., 99 Cedar street, N. Y.
New Britain Machine Co., New Britain, Conn.
N. Y. Safety Steam Power Co., 30 Cortlandt street, N. Y.
N. Y. Car Wheel Works, Buffalo, N. Y.
N. Y. Telephone Co., 18 Cortlandt street, N. Y.
Oswego Boiler Works, Oswego, N. Y.
Otis Electric Co., 38 Park Row, N. Y.
Onondaga Dynamo Co., Syracuse, N. Y.
Paragon Arc Lamp Co., Boston, Mass.
Peru Electric Manufacturing Co., Peru, Ind.
Peckham Motor Truck & Wheel Co., 26 Cortlandt street, N. Y., and Kingston, N. Y.
Partrick, Carter & Wilkins, Philadelphia, Pa.
Paragon Electric Fan Motor Co., 39 Cortlandt street, N. Y.
Porter & Remsen, 39 Cortlandt street, N. Y.
Prindle Pump Co., 136 Liberty street, N. Y.
Partridge Carbon Co., Sandusky, Ohio.
Pope Manufacturing Co. (Motor Carriage Department), Hartford, Conn.
Platt Manufacturing Co., O. S., Bridgeport, Conn.
Roebling's Sons Co., John A., Trenton, N. J.
Riker Electric Motor Co., 45 York street, Brooklyn, N. Y. (Electric Vehicles.)
Safety Insulated Wire & Cable Co., 229 West 28th street, N. Y.
Stephenson Co., Ltd., John, 47 East 27th street, N. Y.
Silex Insulation Co., 39 Cortlandt street, N. Y.
Sprague Electric Co., 20 Broad street, N. Y.
Simonds Manufacturing Co., Pittsburg, Pa.
Sinclair, D. J., Caledonia, N. Y.
Street Railway Journal Co., New York.
Street Railway Review, Chicago, Ill.
Shaw, H. M., 126 Liberty street, N. Y.
Samson Cordage Works, Boston, Mass.
Translucent Fabric Co., Quincy, Mass.
Thomas & Sons Co., R., East Liverpool, Ohio.
United States Electrical Supply Co., 141 East 25th street, N. Y.
Universal Electric Co., 126 Liberty street, N. Y.
Vacuum Oil Co., Rochester, N. Y.
Van Horne, Burger & Co., Dayton, Ohio.
Worthington, Henry R., N. Y.
Walker Co., Cleveland, Ohio.
Weston Electrical Instrument Co., Newark, N. J.
Warren Electric Mfg. Co., Sandusky, O.
Williams & Co., J. H., Brooklyn, N. Y.
White, J. G., & Co., 29 Broadway, N. Y.
Western Electrician, Chicago and New York.
Worthington Water Tube Boiler, 30 Cortlandt street, N. Y.
Williams, J. P., 39 Cortlandt street, N. Y.
Warren-Medbery Co., Mechanicsville, N. Y.
Wilday, J. H., 23 Duane street, N. Y.
Warren Electric and Specialty Co., Warren, Ohio.
Zimdars & Hunt, 127 Fifth avenue, N. Y.
Ziegler & Co., Boston, Mass.

TROLLEY PATENTS.

News comes to us from Cleveland, O., on April 11th, through the columns of "The Brooklyn Daily Eagle," as follows: "The Walker Manufacturing Co. received notice of a decision from the New York Court of Appeals, which, it is claimed, makes the electric street trolley patents public property. Under patents granted to Van de Poel, the General Electric Co. has for years held the exclusive right of manufacturing trolleys. Some time ago the Walker Co. began the manufacture and sale of an electric trolley on an extensive scale, resulting in a series of suits against that company by the General Electric Co. In his last statement of the assets of the General Electric Co. President Coffin included an item of $1,000,000 as the value of the Van de Poel trolley patents."

THE DEVELOPMENT OF ELECTRICAL SCIENCE.

(Contiuued from page 185.)

The effect of electrificatio on the flow of water has received considerable attention from eminent authorities in recent years, and that of the effect of electrification on the growth and composition of vegetable is at present attracting attention in the form of systematic investigation.

The contributions of Franklin are by far the most important which mark the middle portion of the 18th century. Franklin's experiments were begun about the middle of the year 1747, and seem to have been inspired by the receipt of a Leyden jar from a friend, William Collinson, of London. He propounded the theory of positive and negative fluids, which has lately, in a modified form, been brought so prominently into notice again by the writings of Lodge, and he made an investigation of the principle of the Leyden jar, but the most important of his researches relate to the identification of electricity and lightning. The probabl identity of the two phe nomena had been hinted at, as we have seen, by several observers, but Franklin went systematically to work to test the hypothesis. Under date of November 7, 1749, the following passage is found in his note-book: "Electric fluid agrees with lightning in these particulars: (1) Giving light. (2) Color of the light. (3) Crooked direction. (4) Swift motion. (5) Being conducted by metals. (6) Crack or noise in exploding. (7) Subsisting in water or ice. (8) Rending bodies in passing through. (9) Destroying animals. (10) Melting metals. (11) Firing inflammable substances. (12) Sulphurous smell. The electric fluid is attracted by points; we do not know whether this property is in lightning. But since they agree in all the particulars wherein we can already compare them, is it not probable that they agree likewise in this? Let the experiment be made." The hypothesis was elaborated and

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sent to his friend Collinson, who communicated it to the Royal Society. This Society rather ridiculed Franklin's ideas at first, but his paper was published in London and also in France, and attracted considerable attention.

The experiment was first made in France by M. d' Alibard, at Marli, on May 10, 1752, and it was repeated shortly afterwards by M. de Lor, in Paris. The results of what were called the Philadelphia experiments were communicated to the Royal Society and caused quite a stir in scientific circles. It is right to say, with regard to the Royal Society, that Franklin's claims to scientific recognition were championed by Sir William Watson, and fully endorsed by the Society by his election to a fellowship and the award of the Copley Medal, together with the free donation of the Society's Transactions during his life.

Franklin's own experiments with kites are well known, as is also the method of protecting buildings from lightning which was introduced by him and is still very widely used, although it has been greatly abused by the lightning-rod man.

During the next decade Canton discovered the now commonly-known difference between vitreous and resinous electricity. Beccaria experimented on the conducting power of water. Symmer made a number of interesting experiments on the electrification of different kinds of fabrics by friction, and propounded a theory of two electric fluids. Contemporaneous with these were a number of other experimenters who added to the stock of knowledge of this class of phenomena.

The experiments of Aepinus and others on the pyroelectric properties of tourmaline now began to attract attention. The experiments of the Abbé Haüy are perhaps the most important in this connection at this stage of the subject. He found the polar properties of the crystal and showed that similar properties were possessed by a number of other crystals. Aepinus made experiments in other branches of electriciy, but he is chiefly noted for his ingenious single-fluid theory of electricity.

Between the years 1770 and 1780 the electrical organs of the torpedo were one of the principal topics of discussion. The experiments of Walsh and Ingenhousz were the first to definitely settle the character of the peculiar power of the fish.

The experiments of Cavendish belong to this period and were remarkable as being quantitative in their character. Considering the means at his command, the measurements made by this experimenter of the relative conducting powers of various substances must always excite admiration. Cavendish also proved the composition of water by causing different proportions of oxygen and hydrogen to unite by means of the electric spark.

We now come to the classical experiments of Coulomb, who established the law of the variation of the electric force with distance to be that of the inverse square—a law which had previously been inferred from experiments on spheres by Dr. Robinson, who, however, did not publish his results. Coulomb made an elaborate series of experiments on the distribution of electricity over charged conductors as influenced by shape and the proximity of other charged bodies. His theoretical and experimental work formed the basis of the mathematical theory as developed shortly afterwards by Laplace, Biot and Poisson, the work of the latter being particularly important.

Toward the end of the 18th century were made the important researches of Laplace, Lavoisier and Volta, and of Sausure in the electricity produced by evaporation and combustion. This is a subject destined to figure prominently again in the future, and in its rise there is in all probability involved the rapid decline in the importance of the steam-engine. I should not be surprised if many of those present should live to see the steam engine practically a thing of the past.

In the 18th century also we must assign the discovery of Galvanic electricity, as the famous frog experiments were made in 1790. Practically no development was made, however, until Volta's work attracted the attention of the scientific world.

At the beginning of the 19th century, then we find the subjects of greatest interest were the discoveries of Volta and the invention of the voltaic pile. There followed almost immediately the discovery by Nicholson and Carlisle of the decomposition of water by the voltaic current. This discovery was followed a few years later by those of Sir Humphry Davy on the decompositiou of the alkalies and the separation of metallic sodium and potassium. Thus the subject of electrolysis was fairly launched, and what it has grown to be we will see later.

(To be continued.)

ELECTRIC ELEVATORS.

BY PERCIVAL ROBERT MOSES.

From Engineering Magazine, December, 1897.

The question of prime importance in elevator design is that of safety. Economy of operation and ease of control are large factors, but, no matter what else may have to be sacrificed, human life must be secured. Accidents may occur either from carelessness or from faulty design. The former may be guarded against, but not absolutely prevented ; for the latter there is no excuse. A system, to be absolutely safe, should include apparatus for preventing a drop, should all the ropes break at once, or if one should fail, for preventing abnormal speed due to excessive load or other cause ; for holding the car stationary on the removal of power, or under any possible conditions of overload ; for absolutely arresting the motion of the hoisting machine, and for removal of power when the car approaches the limits of travel ; for immediate removal of power from the hoisting machine in emergency, if the cables slacken or in case of temporary cessation of supply ; for receiving and stopping the car and the counterweight, should all the other devices fail to operate ; for prevention of operation until hoistway doors are actually closed. The last condition is rarely fulfilled, the automatic house machine being alone in its compliance. Speed is of sufficient importance in the majority of cases to offset the results of possible carelessness on the part of the operator. In addition to the apparatus above mentioned, the cables for hoisting, the safety clutch for gripping the rails, the sheaves, bearing, and, in fact, all vital parts, should be of a strength far in excess of average actual requirements. This strength costs little, and is of great importance. Easy, reliable control and economical operation are in a degree opposed, if the fixed charges are included in the latter. An ideally-controlled elevator would be capable of starting the car from rest with uniformly and rapidly accelerated velocity and minimum waste of power ; of running the car at varying speeds, and of arresting motion, easily for ordinary stops, and immediately for emergencies. It would be noiseless, simple, and absolutely reliable in its action, and in case of accident or carelessness of operator, should automatically stop the car. It would be so designed and constructed as to preclude accident, no matter what the operator might attempt to do. These conditions are hard to realize completely in one system, but they have been partly fulfilled by several. Two general methods of control are recognized. The first allows of varying the speed from the car ; the second does not, except for starting and stopping. The object of the first method is obtained in two ways—by a pilot motor operating to vary resistance in the main circuit, as in the Sprague system, with an inverse variation of the motor field strength ; and the variable voltage, or Leonard, control, where each elevator motor has a separate generator, and the speed of the car changes in accordance with the varying electric pressure of the generator. This pressure is determined by a resistance in series with the small field current, and is ad-

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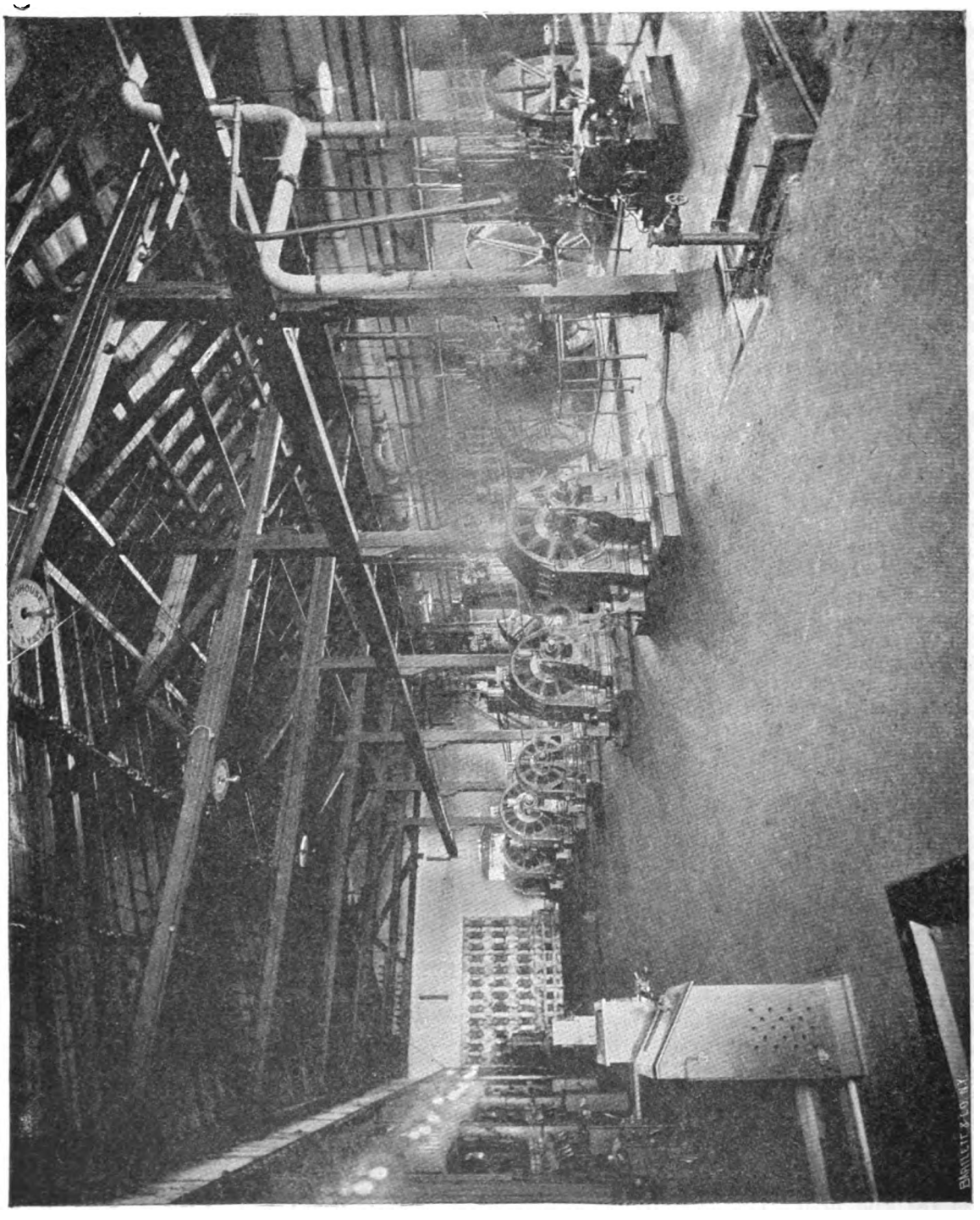
justed from the car. Both methods meet most of the conditions imposed, and the question of choice for all speeds of less than 350 feet per minute is one of comparative economy. The Leonard system is employed only for worm-gear machines, and could not be operated with the present make of screw and multiple-sheave machine. The variable voltage system allows of an ideal start and stop, whether from the standpoint of economy or from that of comfort; on the other hand, from the point of total economy in operation, the rheostat control is advisable because of the necessarily continuous operation, and the first cost of a separate generator for each machine. The proportion of time during which a car is in actual motion varies with the class of travel, but even in ordinary office-buildings it rarely exceeds five-eighths, and generally falls below one-half of the total operating period. In addition, each generator must be of capacity sufficient for the maximum starting load, and consequently runs at low efficiency. In this connection, the following data from seventeen elevators, taken at random from more than a hundred tests, is of interest: The speed varied from 60 to 450 feet per minute, the maximum capacities from 1,500 pounds to 3,000; the maximum live load was 1,600 pounds, the minimum 150 pounds, and the average only 593 pounds. A test on a tall office-building showed the average load to be less than one-seventh of the maximum, and the figures on another, where the elevators were apparently worked to their fullest capacity, showed it to be less than one-fifth. In general, the average live load varies from one-fifth to one-eighth of the maximum. As far as statistics show, the variable voltage system is less economical and simple than the ordinary rheostat control when applied to worm-gear machines; in smoothness of starting and operation it is superior. For low-speed machines, or for buildings where variable speed is not essential, a solenoid control answers all purposes, and its operation may be controlled directly by electricity from the car, or the shipper rope and wheel may be employed to close switches on the machine and operate the brake.

(To be continued.)



Alternating Current Station and Switchboard.

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WIRING FOR LIGHT AND POWER.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

(Continued.)

The wiring of buildings is the ultimate end of a street subway system. The current is generated in a central station, distributed either as an alternate or continuous current through the streets in conduits specially prepared and then connected to the wiring circuits of any house, hall or public building.

The entire city is completely enclosed by a network of underground wires, each insulated from the other and proportioned in size so that the proper pressure and current is delivered at the door of every consumer's house.

The control and care of a subway system is in itself a duty of a most important character.

There is a likelihood of several kinds of trouble developing. Each must be discovered and treated in a manner sufficient to remove either itself or the cause as speedily as possible. There is every means observed on the part of central station managers to take the most jealous care of their subways. It is in the perfection of these and their freedom from faults that the profits of the plant mainly lie.

The wiring of a building can therefore be regarded as the final outcome of an elaborate equipment composed of

(1) A central station plant.
(2) A subway or distributing system.

The main points to be considered in the construction and maintenance of an electric-light system, with special refereuce to the lines either inside or out, are

Freedom from grounds.
Freedom from short circuits.

A series of less important troubles are constantly developing, which will be the cause of further difficulties if not immediately attended to, such as

Poor connections.
Bad joints.

Poor Connections.—The origin of this fault is either hurry or carelessness.

Fire may frequently be started by either of the above causes; their elimination, therefore, is an enforced necessity.

A wire loosely placed under a screw will generate heat and possibly set fire to something in the neighborhood. In addition the looseness of contact will mean resistance in circuit with the line and cause a decided drop. The evil results in this case are practically similar to those developed in the second case, due to bad joints. They are risks from fire or loss of pressure.

How a Building Is Wired.—When a structure of any description is placed in a contractor's hands to wire, it is necessary for him to decide upon several things.

These may be brought to the reader's notice as follows:

(1) The kind of wiring (either 2 or 3 wire).
(2) The percentage of drop.
(3) The centre of distribution.

The nature of the wiring will depend to a great extent upon the kind of current entering the building—whether it is continuous or alternating. Usually buildings that use alternating current are wired with the ordinary two-wire system. The two factors affecting the size of wire or amount of copper used are the percentage of drop and the centre of distribution.

To wire a building successfully the pressure must be retained throughout as high as possible. A network of wires must therefore be used that will effect this result, and it becomes necessary in retaining this object to select a proper centre of distribution.

A centre of distribution in a wiring system is a point from which all wires supplying the electric light direct are connected. The wires used in any building, according to their function, may be classified under the heading of

Mains.
Feeders.
Branches.

A building of given size would have a pair or pairs of main wires run up half, quarter, or one-third way, and then from this point feeders would run above and below, acting as subsidiary mains, and supplying the branches connecting to the lights on the upper and lower floors. This centre, from which all lines stream, is called in compliance with its intended object—the centre of distribution.

The wiring of a house as regards its mains, feeders or branches, may be all proportioned by a simple rule whose excellence has been tested in numerous cases. The pliancy of this rule is due to the fact that it takes into consideration the distance in feet, amperes and circular mils.

$$\frac{2 \times \text{distance in feet} \times \text{amperes} \times 12}{\text{volts drop.}} = \text{C. M.}$$

where C. M. = circular mils.

The application of this rule may be illustrated by the following example:

Distance of run = 1,000 feet,
Amperes = 50 "
Volts drop = 10 "

$$\text{Size of wire in C. M.} = \frac{2 \times 1{,}000 \times 50 \times 12}{10}$$

$$= 120{,}000$$

= No. 00 B. & S. guage.

The size of any copper conductor may be found provided the volts lost, the number of lamps and the length of the run in feet is known; an excellent rule for arriving at the size of wire is to remember that a No. 10 wire B. & S. has about 10,400 C. M. cross section, and each wire three sizes above or below doubles or halves in cross section. For instance, a

No. 13 B. & S. approx. 5,200 C. M.
10 " " 10,400 "
7 " " 20,800, etc.

This will enable a rapid mental calculation to be made of the size of wire from the circular mils obtained.

Twice No. 10 is No. 7, and four times No. 10 is No. 4, etc. In the last case the C. M. arrived at were 120,000. A size of wire about 12 times as large as a No. 10 would have 120,000 C. M. We therefore consider

2 × No. 10 = No. 7
4 × 10 = 4
8 × 10 = 1
10 × 10 = 00

The main fact to consider is, that when a wire doubles in circular mils it decreases three numbers in size.

A No. 10 wire is 10,400 C. M.; a wire twice its circular mils would be 20,800 C. M., but pass in number from No. 10 three sizes, or become No. 7.

The intervening gaps may be filled in in thirds in the following table:

Approx.	166,400	No. 000 =	167,805	C. M.
"	83,200	1 =	83,694	"
"	41,600	4 =	41,743	"
"	20,800	7 =	20,817	"
"	10,400	10 =	10,382	"
"	5,200	13 =	5,178	"

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THE INTERNATIONAL HEALTH EXPOSITION will open in a blaze of glory at the Grand Central Palace, 4th avenue and 44th street, April 25th. Luther Stieringer, the exploiting electrical engineer, has the electrical effects in his charge, and B. E. Greene, the well-known newspaper man, secretary of the Exhibition, is looking after the exhibits. A big, promising show is expected. The officers of the Exhibition are Montgomery Maze, treasurer; B. E. Greene, secretary; Chas. F. Wingate, supervising director, and Luther Stieringer, consulting engineer. The International Health Exposition has received the co-operation of the Household Economic Association. In conjunction with the Exhibition there will be a Trained Nurses' Educational Exhibit, under the management of Miss Mary E. Wadley, assisted by Miss Anna Schenk.

THE ELECTRICAL EXPOSITION,

Madison Square Garden, May, 1898.

Do you intend to add to the brilliancy of the occasion by decorating your exhibit with incandescent lamps? If so, we have the regular decorative (miniature) lamps and receptacles for rental.

Shall you not want an electric sign, so that he who runs may read—and he who reads may run—to your exhibit? If so, we have them for rental.

How about an attractive illuminated device for your exhibit? Just about now The American Eagle and Shield is a good thing for all of us to keep in view. We have them and other devices, patriotic and otherwise, for rental.

Edison Decorative and Miniature Lamp Department,
General Electric Co, Harrison, N. J.

MONTAUK MULTIPHASE CABLES.

In another column will be found an open letter to the Montauk Multiphase Cable Company from the Gamewell Auxiliary Fire Alarm Co. We wish to call the especial attention of our readers to this letter.

The Montauk Multiphase Cable Co. have originated and developed a new line of cables which when installed for any or all kinds of interior electric service give to property owners and to insurance companies an ad itional protection against loss by fire always sought for, but heretofore unknown.

This system gives to wires the power to discover dangerous heat or flame and automatically to notify at any point or points desired that such heat or flame is in existence, and this upon its inception.

The great merit and pronounced value of these cables is from the fact that they are not required to be especially installed for this purpose, but, on the contrary, are used in buildings for all of the interior electric work which is at the present time required; therefore, every fractional part of every wire or cable hereafter installed under the Montauk Cable System is continuously thermostatic and results in giving protection from loss by fire, although installed for purposes of an entirely different nature.

The property-holder is not only benefited by gaining additional protection for life and property, but the insurance companies have an additional guarantee against loss through the use by the public of this system; therefore the value of the indorsement and adoption of the Montauk Multiphase Company's System of interior, automatic, thermostatic, electric cables by the Gamewell Fire Alarm Company and its auxiliary companies for their specificuse will be readily understood and appreciated when it is taken into considerationthat the Gamewell Co. is the parent of the present extensive fire-alarm system which is in use in over 700 of the largest cities of the United States and have furnished more than ninety per cent. of all the fire-alarm apparatus used in the United States and Canada.

It is from their experience of fifty years or more of endeavoring to give the most reliable and quickest posslbie notification of fire in existence that makes such endorsement of the greatest possible value, for if this company are not experts and capable judges in such matters, there can be none in the United States.

We therefore note with satisfaction these main points brought out in the above-mentioned letter to the Montauk Company, namely, The statement that this cable has received full consideration by the Gamewell people; they have come to the conclusion that an automatic protection can be safely given in connection with their fire-alarm system where no other device has ever been relied upon; in other words, they are willing to rely upon the burning of this cable to close the circuit and thus automatically call out the forces of the fire department through their auxiliary system.

Joseph W. Stover, President.
Geo. F, Milliken, General Manager.
H. F. Bender, Treasurer.
Albert H. Cross, Superintendent.

GAMEWELL AUXILIARY FIRE-ALARM COMPANY,

Executive Office, 19 Barclay Street.

New York, March 30, 1898.

Montauk Multiphase Cable Co.,
100 Broadway, New York City.

Gentlemen—Herewith we send you formal acceptance of your proposal for furnishing us with your "multiphase electric cables."

After full consideration we have come to the conclusion that we will find, through the use of your cable, something long known to be desirable but hitherto impracticable, viz.: a device which we can safely use for the purpose of combining thermostatic fire-alarms with our auxiliary system of connection with public fire-alarm telegraphs.

Yours truly,
(Signed) Jos. W. Stover, President.

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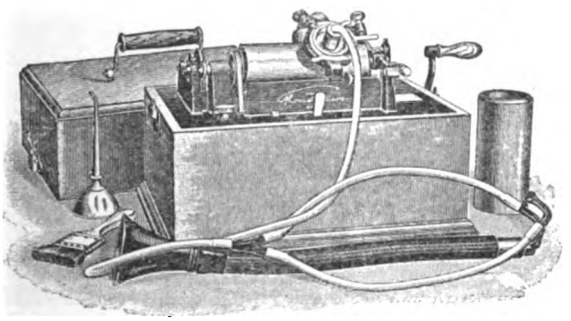

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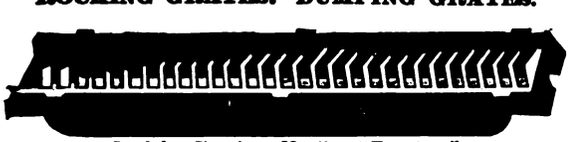

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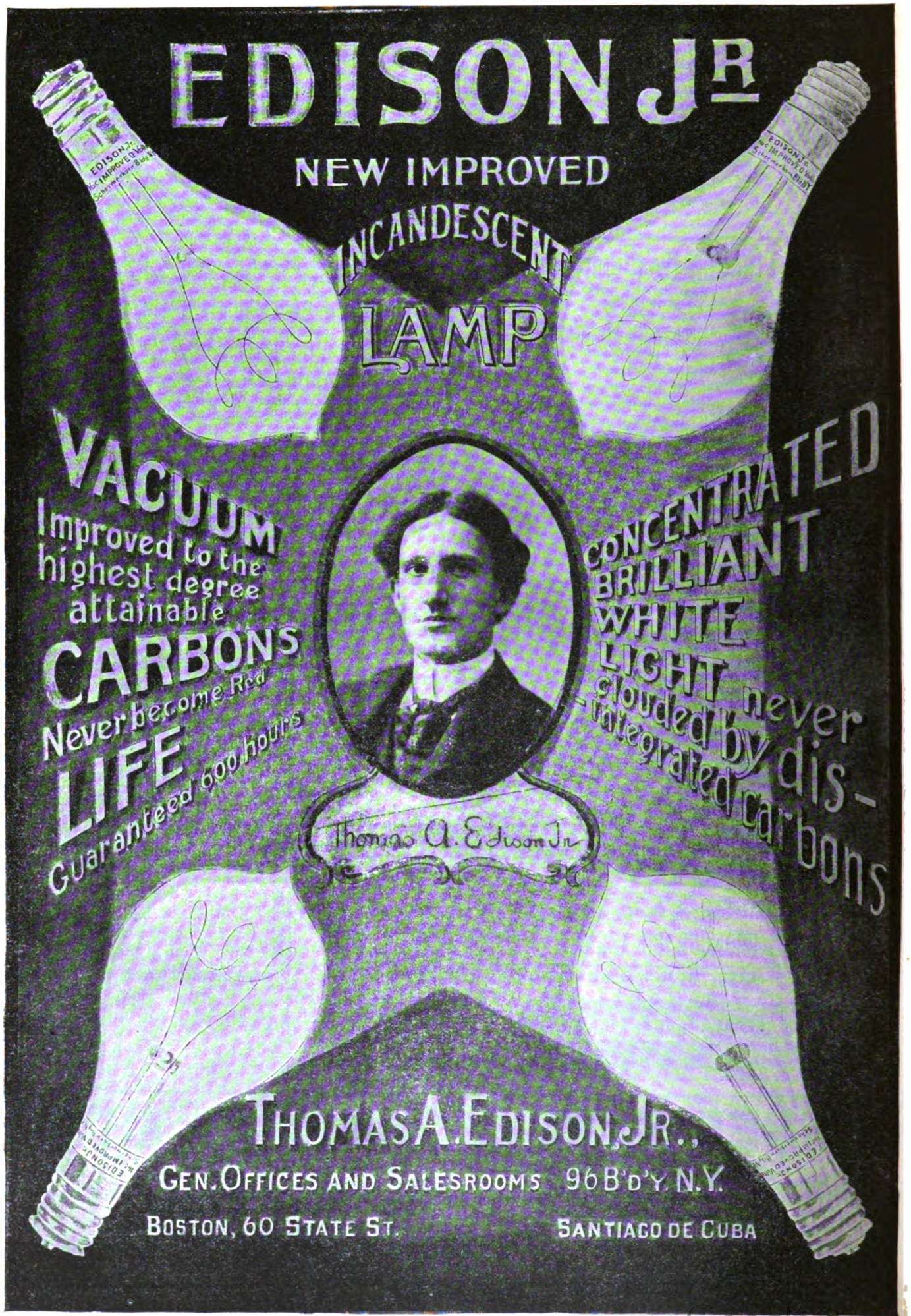

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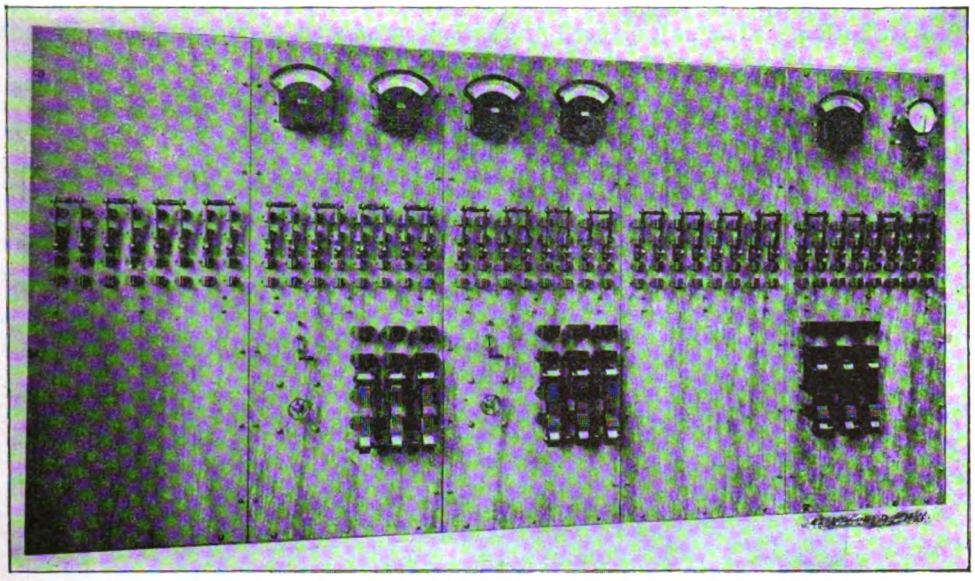
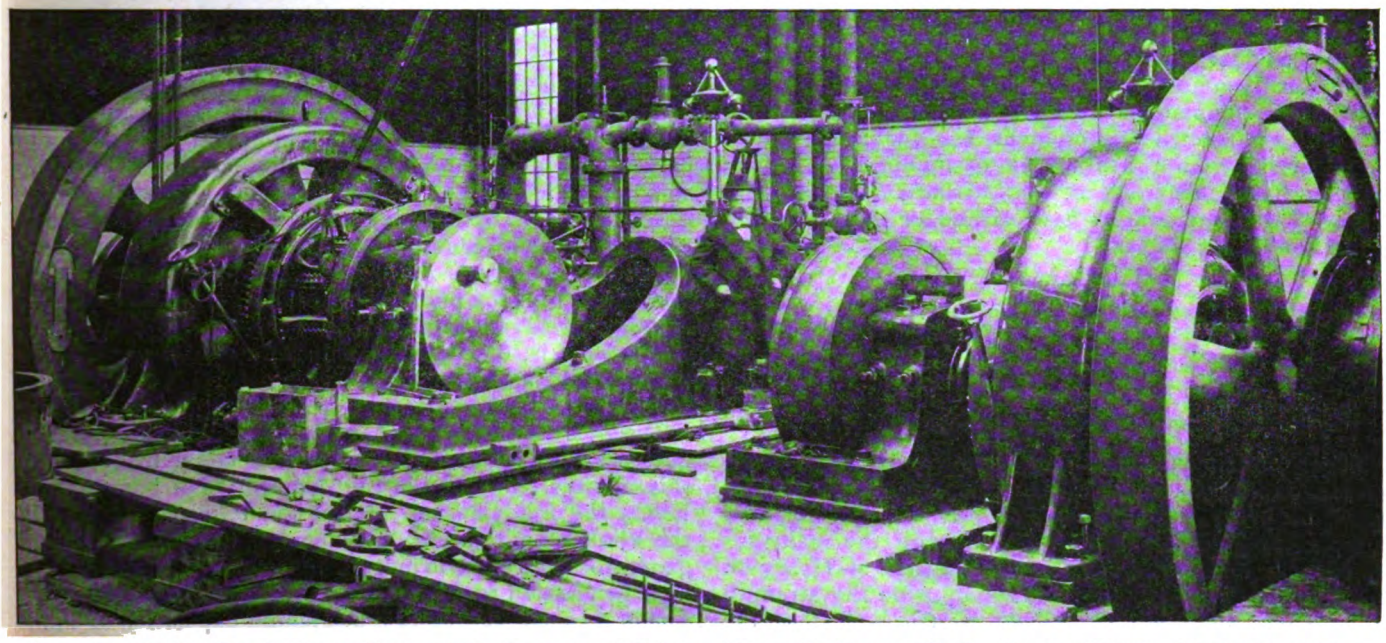
The Electrical Age.

VOL. XXI—NO. 17 NEW YORK, APRIL 23, 1898 WHOLE NO. 571



Front of new Switchboard for Government Printing Office, Washington, D. C. Crocker-Wheeler Electric Company,



Dynamos and Engines in Power House of the Government Printing Office, Washington, D. C. Crocker-Wheeler Electric Company.

A WASHINGTON PLANT.

Since Dr. John Hopkinson, of England, announced in a paper read before the Royal Society of London the true principles upon which a design of the magnetic circuits could be based, investigations have been continued in this and other lines which have led to the construction of highly efficient motors and generators. It seems that but one man in Germany, named Froelich and an American, Prof. Rowland, of Johns Hopkins University, were acquainted with the principle of magnetic design. But unfortunately their interpretation of these principles gave to the scientific world so complex a series of formulæ, containing such constants and variables as to prevent their extended use for practical purposes. The reconstruction of this department of the science was carefully attended to by Dr. John Hopkinson who, formulated the law that the total number of lines of force produced in a circuit of magnetizable material depends directly upon the magneto-motive force and inversely upon those constituents contained under the head of reluctance. The perfection of magnetic and electrical design owes its finishing touches as much to Hopkinson for the practical results obtained as to Edison, Siemens or Kapp. In the illustrations appended to this article the principles of electrical engineering have been carefully followed out.

The Astoria Hotel, of 34th street, New York, has operating in its basement an enormous blower run by a ninety horse power Crocker-Wheeler motor. This machine, of course, runs at a constant load, and the care or attention which it receives after having been started is practically nothing. It runs cool, is efficient, and will probably perform its functions for years to come without any further expense.

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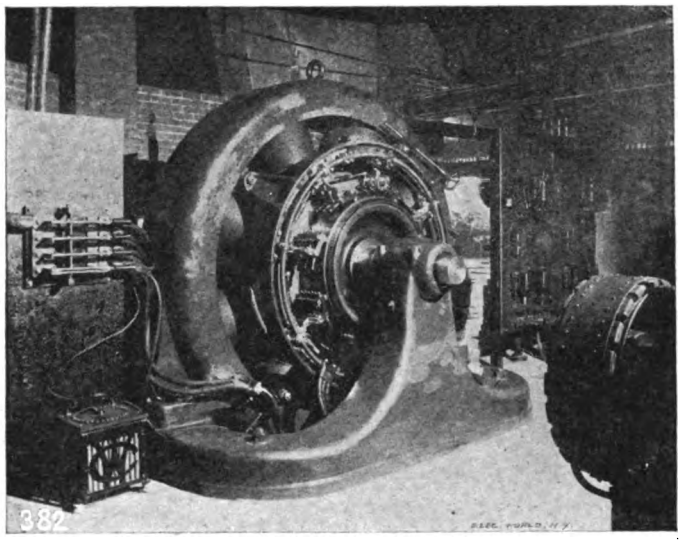
At the Government Printing Office the Crocker-Wheeler Electric Company have installed a plant, which, as represented, sends current throughout the building for light and power. In this building all printed documents relating to the National Government and Consular Reports are prepared for distribution. The switchboard of this plant operates twenty distinct circuits, which control the various floors and subdivisions of power. Slow-speed multipolar dynamos have been installed and, in addition, to drive the dynamos, a steam plant, which, in conjunction with the electrical equipment, has required little or no attention from the first day of its operation. The massive frame, slow speed, sparklessness and high efficiency of these generators have earned for them a lasting reputation in the Capitol.



Special 90 H.-P. size 170 Motor, Direct-Connected to Blower at Astoria Hotel. Crocker-Wheeler Electric Company.

THE DEVELOPMENT OF ELECTRICAL SCIENCE.

(Continued from page 217.)

These experiments mark the discovery of electro-magnetism, and began one of the most important eras in electrical discovery, the work which has been participated in by many eminent authorities. Among the many advances may be mentioned the experiments of Henry on the relative effects of different windings on the strength of an electro-magnet. He deduced the fact that the magnetizing action might be increased either by increasing the number of windings, the current remaining the same, or by increasing the current, the winding remaining the same. He pointed out the application of this to intensity and quantity arrangements of the battery, and also the importance of the intensity winding for the transmission of magnetizing power to a distance, as in telegraphy. The increased effect due to increasing the number of windings on the coil of a galvanoscope had been previously pointed out by Schweigger, and the discovery is embodied in Schweigger's galvanoscope.

In 1821 Faraday began his researches and many important discoveries were made by him. The main guiding idea in Faraday's work was the possibility of obtaining electricity from magnetism and in general the discovery of the inter-relation between the two. In this connection Arago's discovery of the rotation of a copper disk by the rotation of a magnet above it is of great importance, because, among other things, Faraday set himself to explain this. The result was the discovery of the commutatorless dynamo, or Faraday disk. In view of modern developments, probably the most important of Faraday's discoveries was that of the production of a current in a circuit when a current is either established or varied in strength in an adjacent circuit. This was followed by the discovery that relative motion of two circuits, one of which carried a current, produced a current in the other, and that the motion of a magnet in the neighborhood of a circuit produced a current in the circuit. Another important discovery by Faraday was that of the quantitative laws which govern electrolytic decomposition, thus giving us our electro-chemical equivalents.

At this time Lenz was led by experiment to the discovery of his celebrated law of induction, namely, that the current produced always in turn produces forces tending to oppose the change. For example, if a current be induced in a coil by bringing a magnet towards it the mutual action between the magnet and the current is to oppose the magnet's approach. This is important when looked at from the point of view of the conservation of enerrgy or as an argument against perpetual motion. Lenz's law is, of course, when the actions are properly understood, a consequence of Newton's third law of motion.

Discoveries similar to those of Faraday as to induced currents were made almost simultaneously by Henry in this country. We have in the discoveries of Faraday and Henry the fundamental information required for nearly the whole of our recent developments in dynamo-electric generators and electric motors, but it was reserved for the next generation to develop them. This development we owe in no small degree to the splendid exposition of Faraday's discoveries and their consequences contained in Maxwell's book on electricity and magnetism.

Going back for a moment to 1822 we have to notice another important discovery, namely, the thermoelectric couple by Seebeck. There followed almost immediately the important experiment of Cumming, who showed that the thermoelectric order of the metals is not the same at all temperatures.

The next important discovery in thermoelectricity was that of Peltier, of the heat generated at the junction of two metals when a current is forced across it against the e. m. f. of the junction. In later years we have the classic researches of Thomson (Kelvin), who added thermoelectric convection and the specific heat of electricity and gave the thermoelectric diagram method of representing results. This method was afterwards used and extended by Tait, who added a good deal to our knowledge of thermoelectric data. Among the large number of others who have worked in this field we may mention Becquerel, Magnus, Matthieson, Leroux and Avenarius. Thermoelectric batteries of considerable power have been made by Clamond and others.

(To be continued.)

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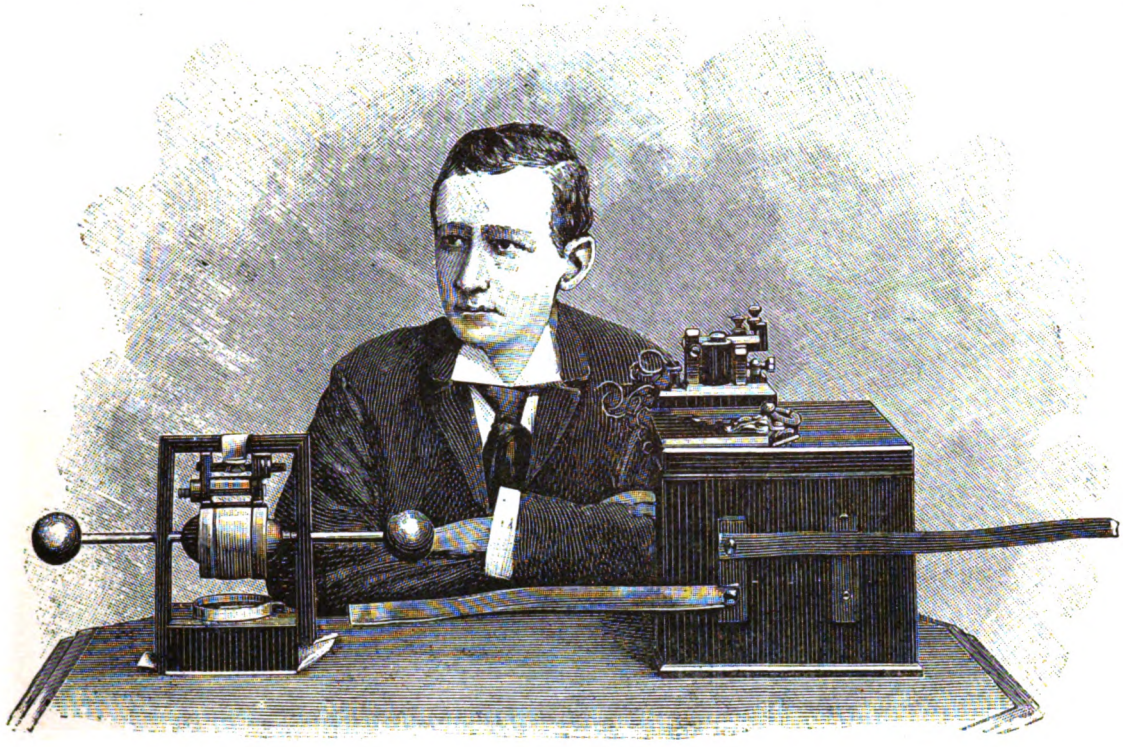
W. J. CLARKE ON WIRELESS TELEGRAPHY.

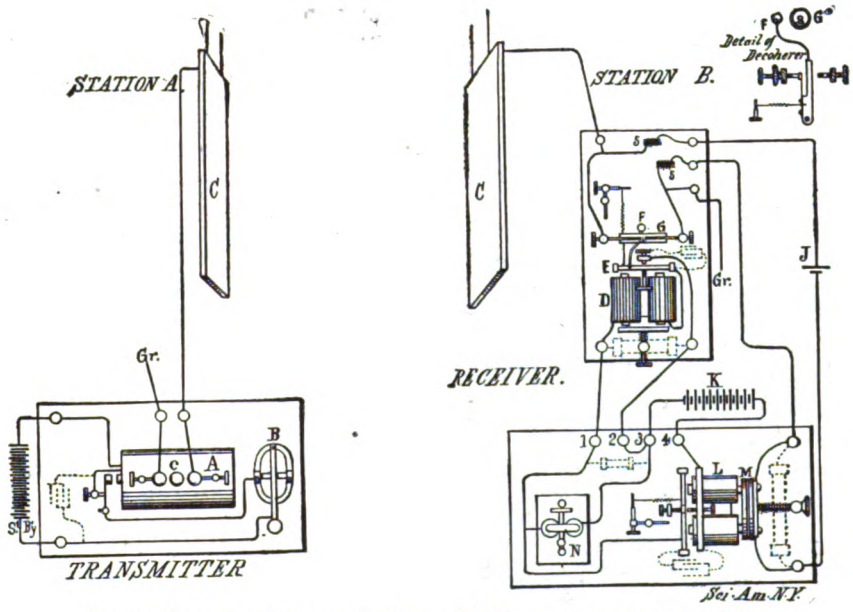
BEFORE THE NEW YORK ELECTRICAL SOCIETY.

Mr. President and Gentlemen:—In commencing this evening I will first of all describe to you the work of my predecessors in the line of wireless telegraphy before telling you what I have myself accomplished during the last few months. Here we have a portrait of Guiglielmo Marconi, who claims to be the inventor of wireless telegraphy. He is a young Italian, now a resident of London, England, and he certainly deserves credit for having accomplished a great deal in this direction, although he has made use of methods and principles which were well known for many years. We will now show you Marconi and his instrument. The transmitter is shown on the right of the picture, and the receiver upon the left. You will notice that all of the apparatus in the receiver is enclosed in an iron box, with the exception of the telegraph sounder. This is done for the purpose of showing that the electric waves will penetrate a mass of solid iron. You now have before you an enlarged diagram of connections showing the method used by Marconi in transmitting signals.

Here in the upper part of the diagram is the primary of an induction coil, which is operated by means of a small storage battery, and in the circuit of which is a Morse key. The secondary of this coil is connected, as you will see, to these two brass balls, which are about an inch and a half in diameter, and placed at a distance of about an inch and a half from these two large brass balls, which are about four inches in diameter; these latter balls are separated from each other by about one-thirtieth of an inch, and their inner hemispheres are enclosed within this heavy rubber tube, d, which is filled with a superior quality of vaseline oil. When the Morse key in the primary of the induction coil is closed, sparks pass across



Wireless Telegraphy Outfit of William Marconi.



Connections showing use of plates with Transmitter and Receiver.

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between all of these balls, and in doing so it will be seen that they have to pass through the bath of oil. These sparks produce electrical oscillations of high frequency, which, in turn, send out electrical waves into space. These waves travel along until they reach the receiving apparatus, which is shown here in the lower part of the picture.

The most essential part of the receiver consists of this small glass tube, d, about an inch and a half in length and one-thirtieth of an inch internal diameter. This tube is

William Marconi.

fitted with two plugs of silver tightly fitting, and separated in the centre of the tube by about one-thirtieth of an inch, the intervening space being partly filled with a mixture of nickel and silver filings. Two platinum wires are soldered to the outer ends of these silver plugs, and pass out through the ends of the tube, the glass being sealed down upon them, so that the air cannot possibly enter the tube, and the filings are thereby preserved from undue corrosion. Attached to each of the platinum wires leading out of the tube is what Marconi calls a wing, which is a metallic plate, W, about a half inch wide, and of such a length as to cause the receiver to be in what we might call "tune" with the transmitter. A small choking coil is attached to the outer end of each of the wings, and the whole is then placed in circuit with this one cell of battery and high resistance telegraph relay, whose contact operates this telegraph sounder, by means of this local battery.

Now when the filings in the glass tube are lying in their normal state they present a resistance to the passage of the current varying from 10,000 to 20,000 ohms, but the moment that the key is pressed at the transmitting station and the sparks pass across the balls, the filings immediately cohere, and their resistance decreases to from seven to twenty-five ohms. This great decrease in resistance is, as you will see, sufficient to cause the current of the one cell of battery to pass through the circuit in sufficient quantity to operate the magnets of the relay, and so operate the sounder. It is found, however, that once the filings in the tube have responded to the waves from the transmitter, they remain in the same condition until such time as the tube has been struck a smart tap, when the filings immediately de-cohere, and the tube returns again to its high resistance. Now it is manifestly evident that, in order to transmit Morse signals, we must have some means of tapping the tube automatically. For this purpose Marconi makes use of this little vibrating arrangement attached to the sounder, the magnets of which are of very high resistance.

Now suppose that the key of the transmitting station is closed, the filings cohere, the relay pulls up its armature, closes the sounder circuit, and at the same instant sets the vibrator attached to the sounder in motion. The tapping of the vibrator against the tube tends to de-cohere the filings and raise the resistance, but everything is so adjusted that the waves from the distant station are just sufficiently powerful to keep the filings cohering, until such time as the key of the transmitter is raised, when the tapping of the vibrator instantly de-coheres the filings, the resistance goes up, the relay releases its armature, and the sounder and vibrator circuit is opened. In this way you will see that it is quite possible to transmit Morse signals, but, although Mr. Marconi has accomplished wonderful results with this piece of apparatus, which he has very ingeniously devised, it is not that class of apparatus which is suited to the American market, on account of the fact that it requires very sensitive adjustment and very careful management.

I will now describe to you some of my own improvements which I have been successful in making in this class of apparatus. I have designed two distinct sets, each consisting of transmitting and receiving devices. One set is capable of transmitting intelligible Morse signals, and the other is used where a cheaper class of apparatus is desired, and where it is only necessary to ring a vibrating bell or operate some similar piece of apparatus at the receiving station. The transmitter is the same in both cases, and consists, as you will see in the picture, of an induction coil specially wound, so as to give the most suitable kind of secondary spark. This coil is mounted upon a mahogany base, together with a specially arranged vibrating device and high-class Morse key, the condenser of the coil being so connected as to kill the spark at the key contact, as well as at the contact of the vibrator. On the upper part of the coil, you will see, are mounted two brass balls, which are one and a half inches in diameter, and arranged so that the distance between them can be adjusted within reasonable limits. When the coil is connected to a suitable battery and the key pressed, sparks will pass between these two balls, and electric waves will be sent out into space.

I find that the greater the distance between the balls the better the effect, provided, of course, that the sparks pass quite freely. I have discarded the use of oil altogether, except in very large transmitters for long-distance work. The transmitter illustrated here, with one-and-a half-inch balls, is capable of transmitting to reasonable distances, and is all that is required for the purpose of

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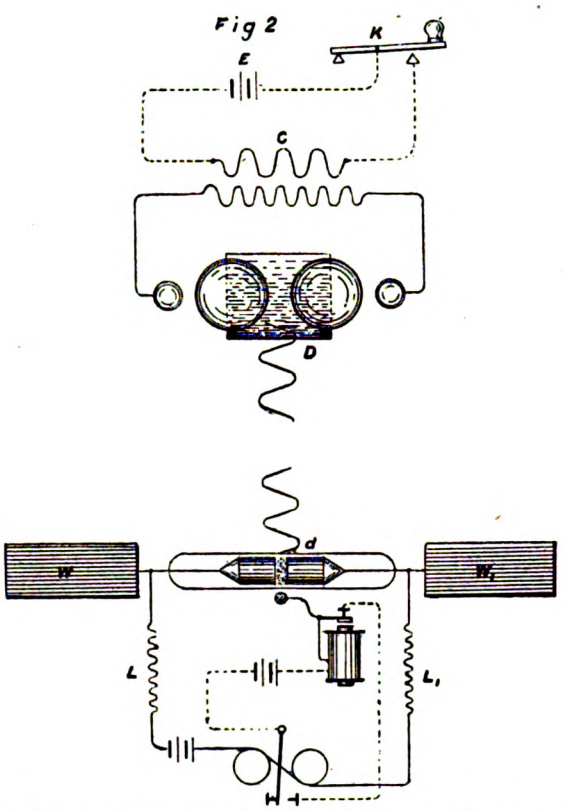
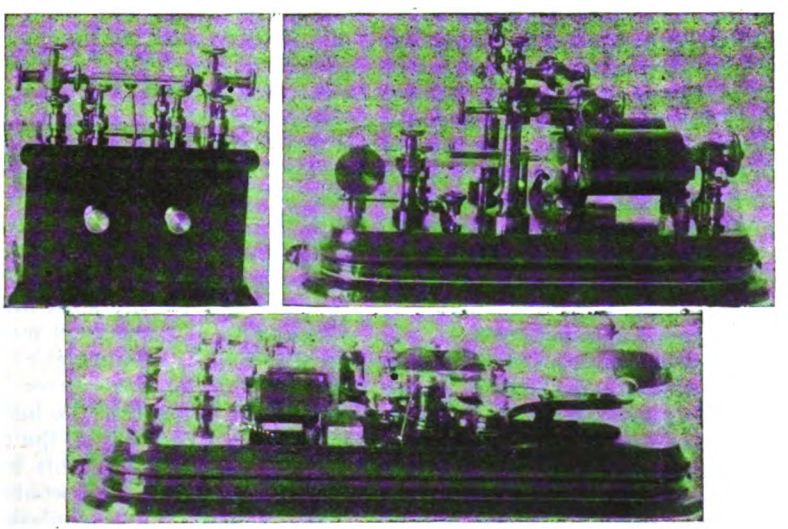
demonstration. The receiver consists of two separate instruments, the de-cohering apparatus mounted upon one base, and a special relay and sounder, together with suitable switches and connections, mounted upon another base. Here we have the de-cohering apparatus. The coherer consists of a glass tube about two inches in length fitted with two brass plugs, arranged with ring and screw adjustments to each, so that the distances between the plugs in the tube and their pressure upon the filings can be readily adjusted at will. The magnets of the de-coherer are specially wound, so as to overcome the effect on the tube of too much self-induction. Every desirable adjustment is provided for, so that not only can we adjust the distance between the magnets and the vibrating armature, but also the tension of the spring on the front of the armature, and the distance through which the armature vibrates.

In this way we are able to so adjust the coherer that the vibrating armature will strike the tube with just the proper strength of blow, so that the filings will not decohere except on the instant that the key is raised at the transmitting station, and, on the other hand, the plugs in the tubes are so adjusted that the filings will immediately cohere when the electrical waves strike the tube, on the key of the transmitter being pressed. The relay in this case, which you will see in the next picture, is wound to a very high resistance, and is placed in series with the glass tube and one cell of dry battery. Its armature is made as light as possible, so as to respond to the most feeble current, and its local contacts are so arranged as to operate the telegraph sounder, and the de-cohering apparatus in multiple, using about twelve cells of dry battery. Here we have the de-cohering apparatus used in the cheaper set of instruments; it is not provided with as many adjustments as the more expensive sets, but these are not found to be necessary where it is only required to operate a sig-



Diagrammatic View of Key, Coil, Transmitter, Coherer, Relay and Decoherer.



Mr. W. J. Clarke's Apparatus for Wireless Telegraphy.

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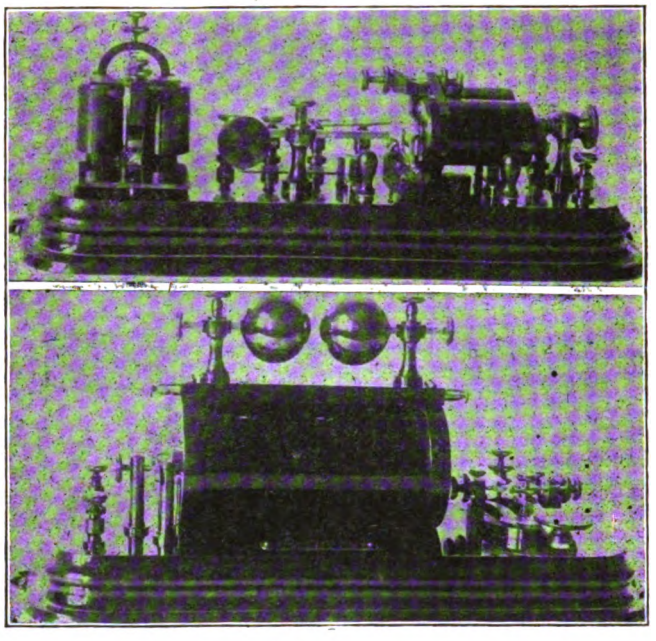
nal similar to a vibrating bell. The relay used in this set, as you will see, is also of a smaller pattern, and is not provided with any means of adjusting the distance between the armature and the magnet cores, these adjustments having to be made by means of the screws at the back and front of the armature. The relay in this case is mounted on the same base with the electric bell or buzzer which it is intended to operate, and the whole outfit gives excellent results for signalling of this kind.

I wish to say here that I have found it necessary to have a special form of dry battery made for this purpose, it being so constructed as not to deteriorate for a very long time, but at the same time it is only intended to be used with apparatus of this kind, where a very small amount of current is required. I will now give one of our diagrams showing all the connections of our best apparatus.



Latest Outfit for Wireless Telegraphy of Mr. W. J. Clarke.

The connections and arrangements of the transmitter which you see upon your left at station A, are so apparent that it will not be necessary for me to describe them further than to call your attention to the manner in which the condenser is connected, so as to include the Morse key, as well as the vibrating contacts. You will notice in this transmitter three brass balls, C, mounted upon the top of the coil; these balls are about ¾ of an inch in diameter, but, as previously explained, we are now using only two balls of 1½ inches in diameter, and I think we obtain considerably better results. One terminal of the transmitter is, as you will see, connected to the ground and the other to plate C, which should be placed as high in the air as possible, and very carefully insulated together with the wire leading to it from the coil. Now coming to the transmitter at station B, we will commence at battery J, and trace the circuit upwards to the binding-post of the de-cohering apparatus. From this post it passes through the choking coil S, and across to one of the plugs in the glass tube; from the other side of the tube it goes down to the other choking coil, and thence runs direct to one of the binding posts of the high resistance relay L, after passing through the magnets of which it returns to the battery J. You will further see that one terminal of the glass tube is connected to the ground and the other to plate C, which is placed opposite to and parallel to plate C of the transmitter. Now it is evident, that if the resistance of the filings in the tube decreases to any considerable extent, the current from the battery J will pass through the magnets of the relay L and energize them. The magnets will now pull up the relay armature and close the local contact, and in order that you may see clearly what then occurs, we will trace out the circuit of local battery K. Beginning on the right the wire leads to binding-post 4 of the receiver; thence to the front contact of the relay across the contact to the armature; from the armature over to the sounder N, and from the sounder to post No. 3, and thence back to the battery, the magnets D of the de-cohering apparatus being placed in multiple with the sounder N, through the binding-posts 1 and 2 of the receiver. In this way you will understand that when the armature of relay L is pulled up, the sounder N gives the down click, and the de-cohering apparatus D begins to vibrate rapidly, the hammer F striking the glass tube with just that kind of blow required to de-cohere the filings the instant the waves cease coming from the distant station, and the moment the filings de-cohere the circuit of the relay L is opened, the armature drops away, the sounder N gives its up click, and the de-cohering apparatus D ceases to vibrate.

In this next picture we have a diagram of the receiver C, used for operating an electric vibrating bell or some similar signalling device. The only difference between this outfit and the one we have just described lies in the facts before stated, that the relay R is not provided with as many adjustments, and is not of such large size, and that the de-cohering apparatus is of a cheaper grade, and also not provided with as many adjustments. This outfit will readily operate the vibrating bell P as often as the key of the transmitter is pressed. It is, however, sometimes found that the bell will continue ringing for an instant after the key of the transmitter has been raised, but for bell signalling this makes little difference, while for Morse signalling it would cause serious trouble, and consequently, the high-class outfit is absolutely necessary where it is required to transmit Morse signals. For those who wish to experiment with the simple coherer, we supply one made up as shown in this next picture, provided with the same adjustments for the plugs in the glass tube as in the more expensive apparatus, and also with two binding-posts for connection through the choking coils, and two other bindings for connection to wings, or to the ground, and air-plate.

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DEATH BY HIGH PRESSURES.

A study of anatomy reveals the fact that high potential discharges attack not only the nervous system but the muscular tissues. A discussion has been aroused between certain physicists as to the true cause of death by electricity. Mr. A. W. Headley, in the London "Electrical Review," discusses the matter as follows: "Death as the result of electricity must occur in one of two ways. First, by mechanical lesions of vital structures, or, second, by arrest of organic functions essential to life, that is to say, by arrest of respiration, heart action, or nutrative exchanges. It is in persons killed by lightning that the first-named mechanical or disruptive effects are usually seen. Industrial currents kill in the second way, but even here the difference is rather quantitative than qualitative. * * * It is self-evident that disintegration of vital parts must cause death. Approaching the second class of cases, where death occurs by arrest of organic functions essential to life, the question broadens out, and it becomes necessary to enquire which of such functions is struck first. Where does death begin? What is the mechanism of death by electricity? At this point physiologists are no longer in accord."

A discussion of this nature is certainly best carried on by medical experts and not those engaged in the development of industrial arts. Yet it is possible for us to generalize and thereby lay down the causes of death as they seem to exist to us. In order to affect the vital centres, sufficient pressure is required to send a current of from one to two amperes through the human body, and it has been determined by a series of gruesome experiments beginning with Kemmler and others that consisted of secondary observations where death by accident had occurred that two thousand volts with fairly good connection will certainly cause death. In other words, we can come to the conclusion that it requires a certain amount of power to kill a man, which could be estimated by the product of two thousand volts into two amperes, namely, four kilo watts.

If the supply of current is great enough in any given case and the pressure exceeds one thousand volts, a shock may and may not cause instant death, whereas there is almost absolute certainty of death resulting from twice the pressure. If a given current is required which can only be obtained by a certain minimum pressure, then there are two classes of effects to be examined into. First, those resulting from the high pressure itself; second, the electro-chemical effects due to two amperes surging through the veins and arteries. One physician believes that dynamic apoplexy, as he calls it, caused by the rupture of innumerable capillaries in the brain, produces death; others that the respiration is prevented, and still others that believe the heart becomes paralyzed. As to the value of all this, we can only say that methods of resuscitation may be improved upon when the causes of death by high pressures are better known.

Mr. Headley's article shows a thorough acquaintance with the subject from a physiological standpoint, but if extermination can be traced to the effects of a given amount of power, then co-operation between the electrical engineer and medical investigator may lead more rapidly to definite and valuable conclusions.

LIQUIFIED AIR AND ELECTRICITY.

The Holland submarine boat has excited much interest in this country and abroad through its remarkable feats at each successive trial. It is acknowledged by naval experts to represent a form of defense wnich may ultimately be adopted by all civilized nations and prove of the utmost value in the protection of coasts and waterways. At present its equipment consists of a storage battery plant, gas engine, dynamo and gas tanks, in addition to receivers carrying compressed air for propelling torpedos. It seems that the stay of this vessel under water is limited, and the present difficulties experienced in its operation are caused by the varied complexities of its machinery. By installing tanks of liquified air and using this for purposes of propulsion, breathing and the projection of torpedos, many of these difficulties will disappear and a most valued addition made to the navy of the United States.

It seems as though the machinery on board could be greatly simplified through the use of liquid air and much space saved which is occupied at present by dynamo, gas engine, storage battery, tanks of compressed air, etc. To those on board, when submerged, at least this satisfaction would remain, that as long as there was power for machinery there would be air to breathe, and this in itself would relieve those that sailed in it of one of their greatest anxieties.

THE GREAT ADVANTAGE offered by the Merchants' Association to business men out of town when buying tickets to New York, pay one way and get a receipt from the ticket agent, for which the association will secure a return ticket for one-third (1-3) fare. This great inducement for business men to visit New York and see the Electric Show in May and make big purchases, saving carfare, is done at a great sacrifice by the members of the Merchants' Association. For all information, address Merchants' Association, New York Life Building, Broadway and Leonard street. The public is invited.

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ELECTRIC ELEVATORS.

(Continued from page 220.)

House elevators have an automatic control, which includes the following features : push button, or buttons, on each floor to bring the car to the landing ; automatic locks, to prevent opening of the door except when the car is about level with the floor ; door switches, stopping the car if door is opened ; and a device preventing the operation or calling of the elevator by more than one person at a time. This control works with complete safety and satisfaction, with the various parts strongly and mechanically made. Small spring-and-trigger attachments are to be avoided, positive action, controlled electrically or mechanically, being substituted. Stopping the car is an important part of the control, and is accomplished by removal of power, brake and short-circuiting for heavy loads, and by the first and either of the other two for light loads. The difficulties are apparent ; a car must be brought to rest within a few feet under widely-differing conditions of speed and load, and this involves as well the stoppage of the hoisting machine, the counterweight, and the sheaves. For this reason with heavy loads a device compelling the car to do work in stopping is almost a necessity for safe and easy operation. For very high-speed machines still another device is used, which allows the brake-band to touch the pulley just before starting, causing the car to perform direct mechanical work, in addition to the electrical work caused by short-circuiting.

The use of a brake depends largely on the construction of the worm-gear. If this is of such a nature as to allow a loaded car to reverse its motion, a brake is a necessity for holding the elevator in position. If the gear will reverse only when actuated by the motor, the brake becomes an emergency stop, and short-circuiting, combined with the friction of the worm, is relied upon for ordinary occasions. This latter method involves the use of a worm-gear with a more acute angle of contact, entailing increased friction and decreased efficiency, and requires a larger current for the down-start and running. It has, however, an added element of safety.

Correct counterbalancing has an important bearing on the successful operation of the car. Efficiency and ease of running are in a degree opposed. Theoretically, that system will be under the best control which has the least inertia ; hence, the use of a counterweight tends to reduce the certainty of control, and this result increases with the speed. Practice has shown, however, that, so long as the car exerts one-quarter to one-half more downward force than the counterweight, no trouble need be feared. With the drum machine and a speed of 350 feet a minute or less, two counterweights may be employed, the car counterweight exerting two-thirds as much force as the car unloaded, and the drum counterweight, the ropes of which wind on the drum in an opposite direction to the car ropes, exerting a force equal to that due to the unbalanced weight of the car and to the average load. Where lights or motors are to be supplied from the generators that supply the elevators, the question of economical operation gives precedence to steadiness of pressure, and it may prove advisable to have the counterweight balance one-half of the maximum load. In high buildings a varying counterweight must also be employed to allow for the change in the force exerted by the ropes, as the car moves up and down the shaft, and for the decrease in load in the upper portion of the building. This variable counterweight is a heavy chain, attached at one end to the bottom of the car, and at the other to the counterweight, or to an anchorage in the hoistway. With high-speed service the car should descend by its own weight, and should never be overbalanced. A system involving the opposite principle—i. e., a counterweight exerting a force greater than the car fully loaded—is in use, and should be condemned. The inertia of the system is nearly doubled, and, in case of accident and failure of safeties, the ropes are sure to break with the car at the top, dropping it the whole height of the building. With reduction of inertia in view, the counterweight for high-speed cars moves at only one-half or one-third the velocity of the car, the weight being increased in proportion. This reduces the total inertia of the system, and, in addition, decreases the cost of the counterweight guides and ropes.

The proper speed for a given building is one which will enable a trip up or down to be made in half a minute without stops. This figure will be modified to a certain extent by local conditions, but is a rough approximation. Apparently the speed should depend on the number of passengers to be carried, but this varying condition must be met by the size of the car, as there are certain periods of the day when the tenants all move, and high speed is of no advantage. Express elevators to the upper half or third of a tall building have been used with doubtful success. Crowding-out of lower-floor tenants is almost prevented, but a number of annoying features have arisen, such as restriction of ease of inter-communication, mistakes in cars, etc. In addition, during all but the "rush" hours, two cars are fulfilling the duty of one. Velocity of service is increased by floor calls and indicators showing the position of the cars. Variable speed is a necessity where the cars are required to run at certain distances apart, or where elevators are run from a lighting plant.

For high buildings, with elevators running from 350 to 700 feet per minute, the increase in the inertia of the system and in the probable and possible strains due to sudden stoppage must be met by increased cable strength, fixed and absolute limits of travel, an underbalanced car with a counterweight moving at one-half or one-third its speed, etc. These conditions are filled only by the hydraulic and screw electric machines. The worm-gear drum machine is unfitted for such work, as it has an endless character of movement, and can not have double or triple ropes on the drum, on account of the size of drum necessary and the impossibility of equalizing their work at the machine.

Continuation of Wiring for Light and Power.

The column obtained on the basis considered and the real value of the circular mils shows that the nearest size to this approximation will be satisfactory.

The development of a wiring system may be easily considered after the sizes of wire have been obtained.

Drop in Mains.—The drop in mains usually allowed is about five per cent., and in feeders and branches two per cent. The loss in the subways leading from the station to the door may be as much as ten per cent., and provided the pressure is kept constant no evil results follow. Variations in pressure in the subway, however well the place may be wired, will cause ruin and damage to the lamps. Either their pressure will fall very low or become too high and derease their life.

Testing.—A ground or a short circuit are two common faults in newly wired buildings. Wires imbedded in moist plaster will show a very low insulation resistance. The insulation test will bring to light the true condition of the building. This is reckoned by the underwriters at a minimum of three megohms (3,000,000 ohms). A Wheatstone bridge is employed for the purpose of localizing trouble. A short circuit will not only blow fuses continually, but show an exceedingly low resistance with the bridge. It may be in a chandelier, caused by crossed wires, or it might be due to defective cut-outs, etc. The blown fuse usually indicates the position of the fault. Grounds are shown by the great and in some cases abnormal decrease in the insulation of the wire. A wire of the bridge connected to a gaspipe and another to a main quickly determines the value of the insulation. When the building is free from grounds, short circuits and poor connections, and shows a proper and reasonable perfec-

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tion, current may be applied to its lamp circuits without further delay.

QUESTIONS FOR REVIEW.

(1) What are the elements of an electric-light system?

(2) What precautions must be taken in laying wires?

(3) In wiring how may trouble be avoided?

(4) What are the principles to be followed in running lines? How is the size of wire calculated?

MEASUREMENT OF CANDLE-POWER.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

In measurements of candle-power a great difficulty has been met with which, although partially overcome, still leaves the final settlement of it in doubt; that is, the use of a standard of light. A gas jet gives sixteen candle-power, an incandescent lamp sixteen, and possibly some oil lamps; but should either be adopted as a standard it is very difficult to keep track of the deterioration in light and feel secure, in using it, that no great error is made. In other words, we have no absolute standard of light, and therefore our methods, though perfect, have not a very accurate foundation. The use of a fixed standard is necessary. In order that a test can be made which will amount to more than an experienced guess, a good reliable standard which will not change very quickly is most desirable. The standards at present in use vary somewhat in their nature. The English candle has been looked upon as best for a long time, but opinions have been slowly changing. The use of other standards has become general, and the following sources of light for photometric tests tried with varying results:

STANDARDS OF LIGHT.

Carcel lamp,
British standard candle,
German standard candle,
Amyl-acetate lamp,
Pentane lamp.

The above are but a few of those that have been tried. One method that appeals to the electrical engineer is the heating of a strip of platinum to a given temperature by a known current, or the light emanating from a crater in an arc lamp. The paper entitled "Standards of Light," read before the American Institute of Electrical Engineers, May 20, 1896, is very complete, and treats this difficult problem in a masterly manner.

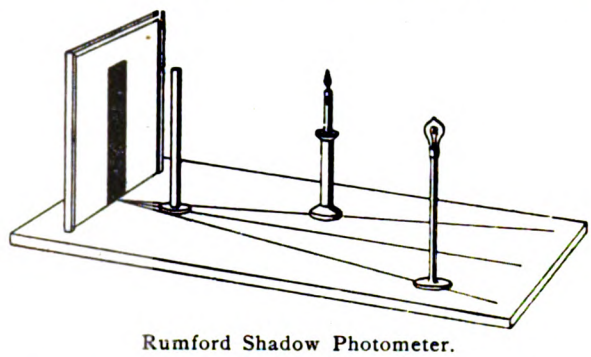
The standard that cannot be depended upon is the English candle; in fact, any source of light subject to such fluctuations and burning with such unsteadiness.

The standard must be of definite chemical composition as well as the medium around it. When a light has been produced that shows but slight variations, the problem of measuring light will be resolved down to a firm basis and become in every sense of the word a science.

In lamp factories a filament carefully made is selected and its candle-power, measured with all possible accuracy, used as a standard for the rest. A dark room is very essential for lamp tests. In any factory making illuminants, or apparatus for such, a photometer room is used constantly. It is simply a room shut off from all daylight. A scale is within; at one end the standard is placed, at the other the light to be measured. Either one is now kept stationary. The screen between with grease spot is used, as in the simplest photometer, for determining the equivalence of the intensity of light on each side. Rumford's photometer employed a screen and made use of the shadows thrown by the standard and other light as a means of comparison.

A stick mounted before a screen will throw two shadows, one due to the standard, the other caused by the unknown light; when both shadows are alike, the respective distances are compared. If the standard is one foot away and the other three feet, provided the shadows thrown are equal, the second is nine times as strong as the first, or nine candle-power.

Daylight is the light all scientists and inventors are striving to obtain. Their object is to produce light without heat, and thus illuminate city and home in the most perfect manner.



Rumford Shadow Photometer.

QUESTIONS FOR REVIEW.

(1) What is a standard of light?

(2) How many and what are the standards in use?

(3) By what reliable means may light be measured?

(4) What is a photometer?

INSULATION AND CONDUCTION.

(Continued from page 212.)

In the formulæ, the valency was introduced. This term has no definite meaning, as the valency varies with the compound. Consider the writer's chart of the elements (Fig. 3), a modification of those of Meyer, Newlands and others. On one side are seen the metals of the arts. Above them in vertical rows are marked the figures 1, 2, 3, 4, etc. These figures indicate the number of chemical linkages which as a general rule the elements under the figures tend to take up. But there is no very definite rule.

Among the univalent metals some unite with bivalent atoms, as does copper, and in general all that can be said is, that a certain valency holds generally and not in general. Consequently, when we find that by taking a group of metals having very closely the same values of Young's modulus, as, for instance, gold, silver and aluminium, their conductivities are, within the limits of errors of observation, proportional to the velocity of sound ÷ valency; and that in any of the group of metals having the same valency the conductivity is directly proportional to the velocity of sound, within experimental

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errors, we are to a certain extent justified in making a choice of valencies when this is needed. Fortunately, however, this only occurs in two cases:

1st, we must suppose copper to have twice the valency of silver, which we might, a priori, have granted, for, though they are in the same group, yet copper has markedly through all its salts twice the valency that silver has. 2nd, that thallium has twice the valency of aluminium, a supposition which has no other justification than the fact that, since the formula holds in other cases where the valency are known, we have a certain right to use the formula to find the valency.

being the period of the heat wave. If this be proven by experiment we would have this relation: The electric conductivities are in the same ratio as the velocities of very short sound waves, being thus analogous to Maxwell's law for the velocity of light in insulators, in that the velocity varies with the periodicity.

We have seen above that the electric resistivity varies directly as the valency. Also it has been indicated that there is some evidence to show that the polymerization or plex varies as the valency Therefore we are led to assume that increase of resistance accompanies polymerization or the linking together of the atoms into groups.

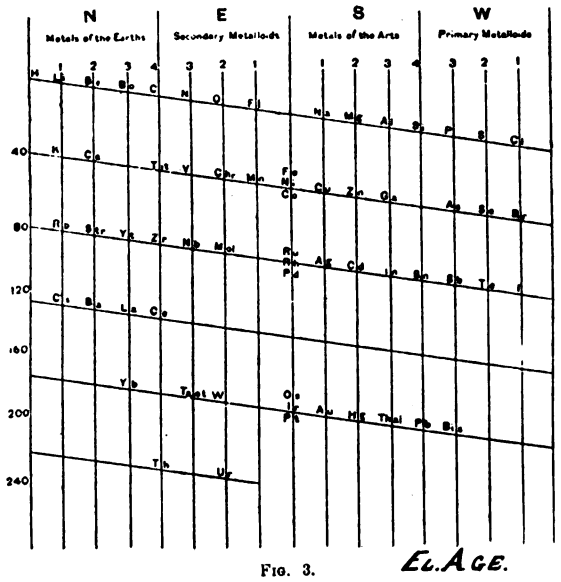

Fig. 3.

Now it is well known, especially from facts in organic chemistry, that similar atoms or molecules can combine together to form what are called polymerized substances. For instance, three molecules of C_2 H_2 acetylene can form one molecule of benzol, C_6 H_6. In general, we find that these polymerized compounds are more crystalline and have higher melting points than the original substance. Also we note that the number of atoms in such a polymer is generally a multiple of the valency of the atom. Carbon, for instance, seems to prefer to go in groups of four.

Considering now the table of elements, we see that as we pass along from row to row, and as the valency increases, the substances get more crystalline and in many ways evince a linking together.

1st. As mentioned, they are crystalline.

2nd. Their specific heats get abnormally low, this indicating that they are polymerized, or plexed.

3d. They are capable of existing in allotropic forms.

4th. Their vapor densities show that several atoms are jointed together into one molecule, and hence they are almost certainly polymerized as solids, since the general tendency of heat is to disassociate. Consequently, there is some evidence for the theory that metalloids differ only from metals in that they have a greater tendency to polymerize from their higher valencies, which are probably in some way dependent upon the shapes of the atoms, and are so more crystalline, etc.

We might therefore look for some evidence of polymerization among the metals. This is readily found, as before, from the variation of the specific heat from its theoretical value. If this linkage were but loose, it is evident that it might affect the specific heat but little, and yet have a marked effect on other phenomena. For instance, we might suppose that it would affect long sound waves less than short ones.*

We might therefore consider that when the period of a sound wave coincides with that of the molecules, it is a heat wave; the period of the amplitude of the sound wave

We see that this might hinder the transmission in various ways, since the groups would not vibrate so quickly as the single atoms, and there would be fewer of them per unit cross-section. Anything, therefore, which tends to give molecular complexity tends to give high resistance; hence we see why alloys are generally higher in resistance than the average of their components.

The resistance increases with density and molecular complexity and inversely with the elasticity. Consequently, whether a resistance increases or decreases with temperature will depend upon whether the molecular union is weakened at a less or greater rate than the elasticity falls off.

In getting a concept of this we may consider a conductor as analogous to a government department, the different atoms or officials being bound together into groups by valency bonds, the analogue to which is evidently "red tape." The rate at which a given impulse is handed on will evidently depend inversely upon the amount of red tape and the density, or stupidity, of the individual official. The two causes are often confused.

We must, therefore, for solid insulation, get substances which are strongly linked together, of great density, and of small modulus of elasticity. The first is the property which varies most, since density and elasticity vary between comparatively narrow limits.

(To be continued.)

* The writer ventures to suggest that the velocity of very short waves of sound in copper may be found somewhat less than half of that given now for audible tones, while that of lead may be reduced to but one-eighth of its value as given at present.

THE THOMSON RECORDING STORAGE BATTERY METER.

The increasing application of storage batteries, consequent on their perfection, to electric light and railway station use, as well as to street cars, motor carriages, electric launches, etc., where a portable source of power

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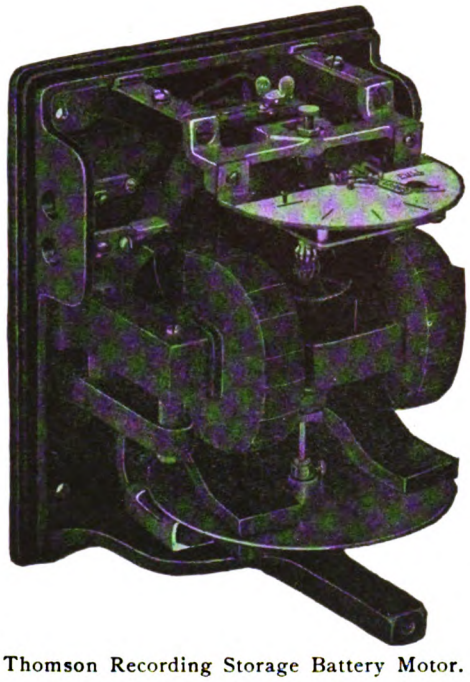
is requisite, has led the General Electric Company to develop a special type of meter, which will show at a glance the amount of energy available in the battery. The Thomson Recording Storage Battery Meter resembles, in general appearance, the standard Thomson Recording Watt-Meter, and is, in fact, a development from it, the mechanism being almost exactly similar. The accuracy and durability characteristic of the standard type have both been maintained, while additional precaution is provided against injury from shock or vibration. The meter is provided with a single indicating needle moving over a horizontal semi-circular dial.

The essential requirement for a storage battery meter is that the armature shall rotate in either direction and give equally accurate readings in both. In this meter



Thomson Recording Storage Battery Motor.

this requisite is fully preserved. The energy put into the cells is, therefore, added to the reading of the meter, while the energy withdrawn is subtracted, but to compensate for the loss in the cells the meter runs more slowly when charging. The reading of the meter represents not the amount of energy put into the battery, but the amount available, and when the needle points to zero on the dial it shows that the battery is completely discharged.

For motor carriage, street car and electric launch service a meter of this character is a most necessary adjunct. Indeed, any of these vehicles of transportation not equipped with a device to warn the operator of the amount of current available to carry him forward on his journey or to bring him back to his starting point would be incomplete. Without it he is absolutely ignorant of the power upon which he can depend, and would run serious risk of finding himself at a stand-stall far from home with no means of getting either forward or backward without recourse to some mechanical method.

The durability and efficient operation of storage cells being maintained by re-charging them before they are exhausted, the only method of learning of their exact condition is by a meter of this character. The cells being recharged at the right time, the general result is a much higher battery economy.

These meters are manufactured with any desired percentage difference between charging and discharging rates, and in all of the standard sizes in which two-wire Thomson Recording Watt Meters are built. Since, however, this percentage varies in almost every case, the General Electric Company manufactures them only to order. One size, that reading to 50 amperes, however, may be considered as standard, and will be more promptly furnished than any other.

A GREAT DEAL OF PUBLIC INTEREST attaches to the work which Mr. Edison has been doing for some few years past in magnetic ore separation, and the general curiosity on the subject will be satisfied at the approaching exhibition, where Mr. Edison will actually exhibit a model built for him by Mr. Sigmund Bergmann, which illustrates admirably the fundamental principle of the process. This model will be kept running by a small motor, and the iron will be continuously separated from the crushed rock in full view. Mr. W. S. Mallory, the manager of Mr. Edison's mining works, is sending to the exhibition samples of crushed rock in its various stages, as well as samples of the separated ore and of the briquettes which are sent to the furnace. He is supplementing this by some four or five-ton masses of rock, which Mr. Edison takes bodily out of the hillside by means of huge excavators, and the magnetic condition of these ponderous masses will be shown and tested by magnets. Around the exhibit will be placed photographs illustrative of the scenes at the mines themselves, and the whole will constitute one of the most instructive demonstrations possible. This valuable exhibit will be placed along one side of the concert hall of the Garden, in company with a number of very interesting special features, which have already been arranged for.

THE SPRAGUE AUTOMATIC HOUSE ELEVATORS are being received with a great deal of favor, and many wealthy men of New York city and elsewhere are placing them in their houses. The machine in its construction embodies a number of highly ingenious features in its method of control, which is entirely automatic. By means of its devices, the machine may be operated from any floor, or from the car itself. By merely pushing a button from any floor, the car is brought to that particular floor without any further manipulation of the controlling apparatus, and when a door is opened it is impossible to operate the machine from any other point, or until the car has reached its destination, and the landing door finally closed. While the car is in operation, it is impossible to operate any of the buttons aside from the one initially connected, and there is also a mechanical locking device at each door preventing its operation except when the car is at corresponding landing. The simplicity and absolute safety of this machine is the great reason for its success.

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MADISON SQUARE GARDEN.

ELECTRICAL MODEL-MAKING COMPETITION FOR AMATEURS

At the request of the management of the Electrical Exhibition, the special committee named below has organized an Amateur Electrical Model-Making Competition with the object of promoting general interest in electrical handicrafts, and of recognizing the work done in that branch of industrial study by individuals or by institutions.

The rules for this competition, the classes, and the awards, are set forth below:

1. The title of the contest to be as above.

2. The objects entered shall be on view throughout the Exhibition, but shall be adjudged by experts the first week.

3. All objects shall be entered under the name of the amateur, student, or students, or instructor.

4. All individual exhibitors, or collective exhibitors, shall make a written statement as to the work being their own, and shall send in also a certificate of good faith signed by clergymen, schoolmasters, justice of the peace, editor, or well-known citizen.

5. The exhibits shall be grouped in a space set aside for them, and shall be fully labeled. Prize awards shall be added as soon as possible to the labels.

6. None of the exhibits shall have been made for sale, or during hours of work in shop, for wages.

7. The judges shall consist of a committee of five, two from the Auxiliary Committee, two from the New York Electrical Society, and a fifth selected by the Exhibition Management, agreeable to the four. The judges to select their own chairman, who shall report the awards made.

8. The objects shall be sent in or delivered by hand, addressed to the Manager of the Electrical Exhibition, Madison Square Garden, not later than the Monday (April 25) preceding the opening of the Exhibition, and labeled "Amateur Electrical Model-Making Competition."

9. Exhibits shall as far possible be operative.

10. The judges need not award the full amount of any prize if the exhibits do not come up to their standard.

11. No exhibit shall be removed during the continuance of the Exhibition.

12. No competitor in this contest shall be admitted who is over 21 years of age, or who is already manufacturing such articles as a means of livelihood. This does not apply to the group of teachers in Class F.

13. The prizes shall be awarded and declared as soon as possible after the opening of the Exhibition, and an evening shall be set apart for presentation of the prizes.

14. There shall be Six Classes of Exhibit, with bronze medals, and a sum not to exceed $50, for each class.

15. The classes are to be as follows:

Class A. Working model, or actual machine of a dynamo-electric or electro-dynamic type, made by one or more boys under 21, so far as designing, lathe work, assembling and finishing is concerned.

Class B. Instrument of precision, made by amateur or student, such as galvanometers, resistance bridges, electrometers, etc.

Class C. Practical application of electricity to communication, the assembling and finishing to have been the work of a single exhibitor (telephones, sounders, etc.).

Class D. Ingenious application of electrical appliances to domestic, etc., uses, by an amateur under 18; none of the parts of the apparatus to be necessarily of home manufacture.

Class E. Design, or working drawing, of an electrical appliance or installation, made within the past twelvemonth by a student of a recognized chartered institution and bearing the instructor's certificate as to its bona fides.

Class F. Design or instrument made by a teacher, below the grade of college professor, for illustrating some electrical law.

Prof. Morris Loeb,
New York University.
Dr. W. E. Geyer,
Stevens' Institute of Technology, Hoboken, N. J.
Dr. C. A. Doremus,
College of the City of New York.
T. C. Martin,
Chairman Auxiliary and Educational Committee.

NEW YORK NOTES.

CRAGE & TENCH, of Buffalo, have secured the contract for building the Lima & Honeoye Falls Electric Railroad. The contract also includes the wiring of the streets of both villages for electric lights, and the construction of the power-house. A large force of men will be put to work on the job next week.

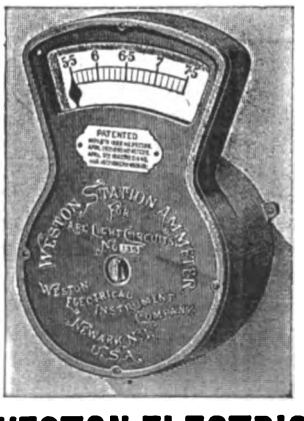
THE EDISON MANUFACTURING CO. have removed from 110 East 93d street to larger and more commodious quarters in St. James Building, Broadway and 96th street.

LOUIS B. HETTY, dealer in electrical supplies, San Francisco, Cal., is in town.

A. W. TUCKER, the popular representative of the Western Electric Co. of Chicago, Ill., was in town, last week, taking orders for fall trade.

HENRY C. THOMSON, Genl. Manager of Electric Gas Lighting Co. of Boston, Mass, was in town this week.

THE BRADFORD BELTING CO. of Cincinnati, Ohio, Manufacturers and Importers, and Jobbers of Electrical Supplies, R. F. Johnson, Eastern representative, office, 15 Cortlandt street, N. Y. They have just secured the order to equip the extension of the People's Light & Power Co., Jersey City plant with a duplicate of the order they filled for this plant in 1897. The largest belt in the world was placed here by the Bradford Co., measuring 165 feet long, 80 inches wide, three hides thick.



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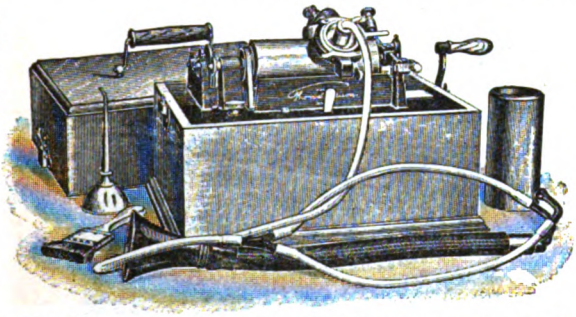

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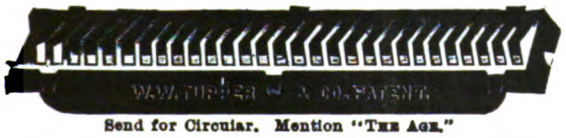

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Is arranged for use with my **Automatic Electric Arc Lamp** on any low tension continuous current of about 115 volts.

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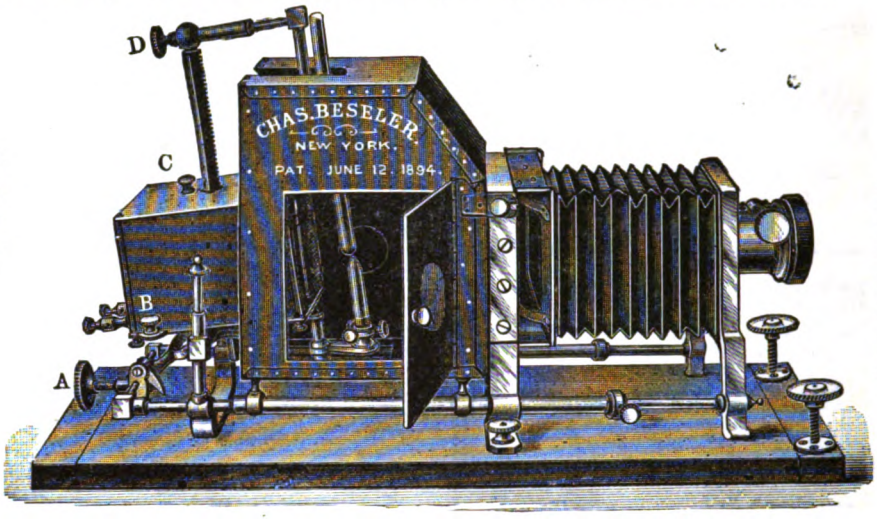

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The above lantern will also admit my "Bijou" electric arc lamp (hand feed) which may be used on either the **Direct** (115 volts) or **Alternating Current** (52 volts). Note—A well constructed carrying case is included at the above price, viz., $120.00, Send for my illustrated Catalogue No. 2.

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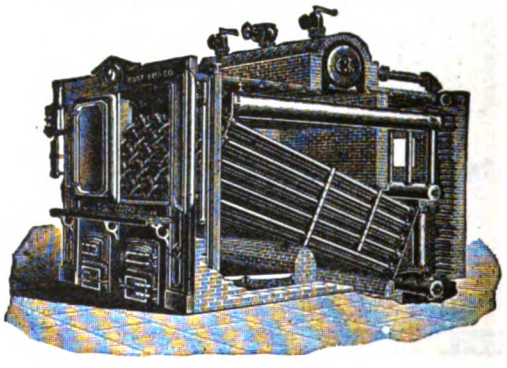

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The Electrical Age.

VOL. XXI—NO. 18 NEW YORK, APRIL 30, 1898 WHOLE NO. 572

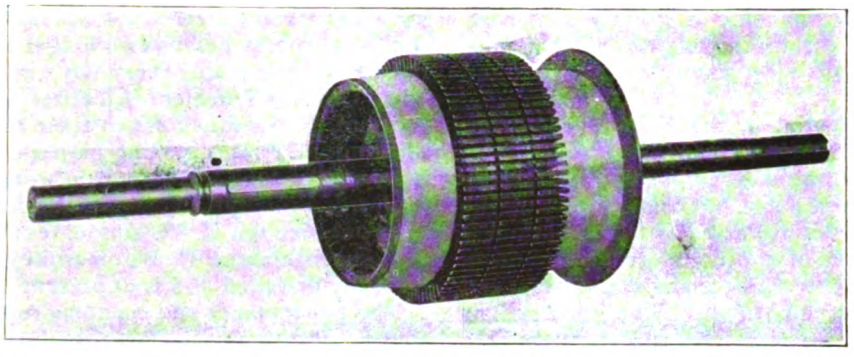

Fig. 1—Iron Core of G. E Armature.

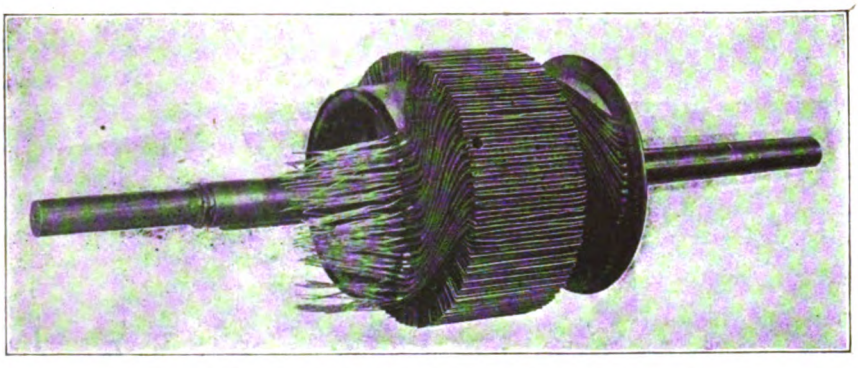

Fig. 2 Method of Applying Coils on G. E. Armature.

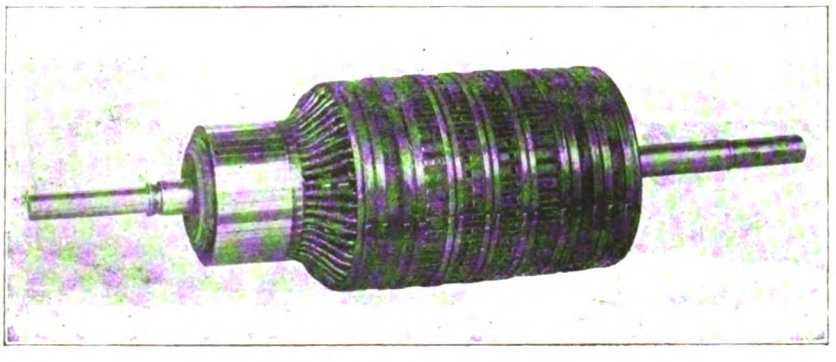

Fig. 3—Complete G. E. Armature.

ARMATURE CONSTRUCTION.

In the construction of the armatures of all direct-current generators and motors built by the General Electric Co., special care is taken in the production of as perfect and durable a part as possible without sacrificing any detail essential to efficiency and perfect operation. New ideas have been incorporated, and old and tried features retained; the wire, iron and copper must reach a certain standard of excellence or be rejected; each step in construction is carefully inspected, and the completed armature is subjected to a test many times more severe than the severest conditions which would be met with in actual service. Nothing is left to chance.

In the armatures of the new type of slow and moderate speed direct-current generators and motors these characteristic features are strikingly apparent. The completed armature is a slotted body of barrel shape so built that no part is susceptible to movement or vibration. There are no sharp bends to the wires over sharp metallic edges, and each coil is so laid on the core that the outer periphery of the core itself affords it complete protection from mechanical injury.

The spider castings holding the slotted sheet-iron laminations, are extended into cylindrical flanges at both ends. The coils previously shaped on a form are laid in the slots, and the ends lie along these flanges at each end of the spider instead of being bent down sharply toward the shaft. The coils are formed and insulated before assembling on the core in order that, before application in their final position, they may undergo a careful test, and no coil is used that does not emerge from this with insulation intact. The insulation used is similar to that employed in the G. E. railway motors, and in the operation of these has given ample proof of its excellent qualities. It is tough, impervious to moisture and practically indestructible, except under abnormal overload, while it affords high resistance to puncture, rendering injury from lightning extremely improbable. The insulated coils are laid in place in insulated slots in the core and are simply pressed home. The advantage of this method, compared with that employed on an armature with the wire wound directly upon it, is obvious.

The cylindrical winding has many positive advantages. A very large radiating surface is provided for the conductors, and this, combined with special air-ducts for the

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passage of currents of air through the core from the interior outwards, tends to keep the armature cool; the length of wire is reduced to a minimum and consequently the losses due to armature resistance are also reduced, while the efficiency of the machine is greatly increased. The complete coil being formed separately and then applied, any one or more coils may readily be removed and replaced.

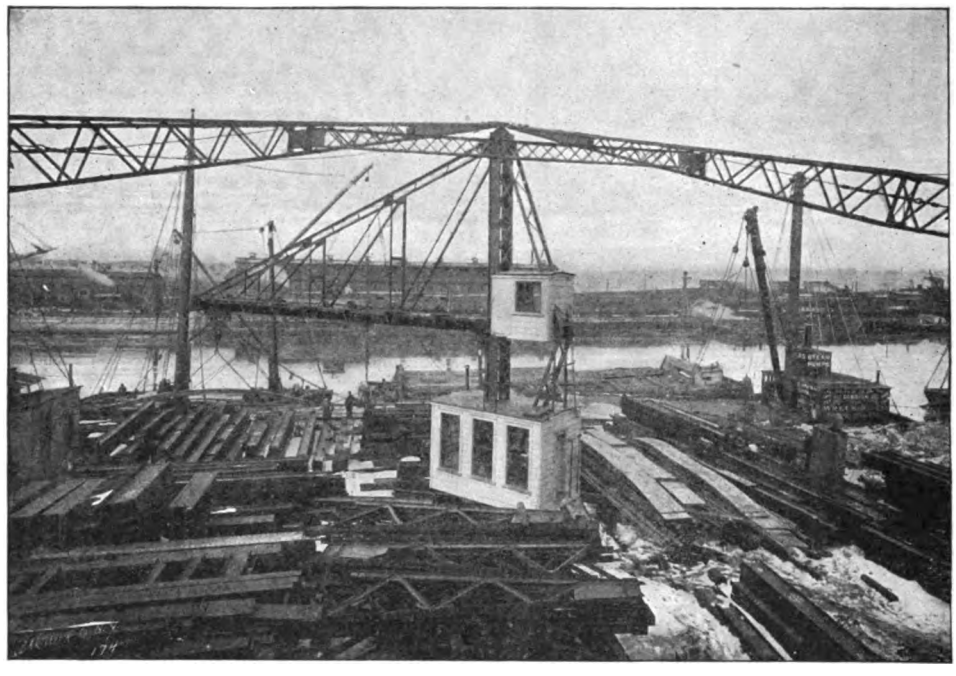
The coils are firmly secured in the slots on the cylindrical extensions so that no part can move or vibrate. Indeed, rigidity is one of the most important advantages of the cylindrical winding, since, without motion of the parts, neither injury nor deterioration of the insulation is likely to occur. The ends of the coils are curved down to the commutator, and the connections are so arranged that open circuiting is impossible. The illustrations show the three different steps in the construction of a General Electric slow and moderate speed generator armature from the completed core to the completed armature. Fig. 2 shows the method of applying the coil to the core.

A GIANT ELECTRIC TRAVELLING CRANE.

Since the unexcelled advantages resulting from the introduction and use of electricity in the arts and industries have been recognized, the use of heavy machinery for special purposes belongs no longer to the field of novelty, but to that of plain, every-day, up-to-date engineering. The Crocker-Wheeler Electric Company's works at Ampere, N. J., make use in their assembling department of a huge electric travelling crane, capable of lifting many hundreds of tons. At the iron works of Messrs. Post & McCord, Brooklyn, N. Y., a ten-ton derrick crane, run by a one-size ten C. W. single reduction motor on hoists and one-size three C. W. on trolley travel has been successfully installed and is at present in operation.

The convenience and economy resulting from the use of these innovations has been prominently advertised by the delighted owners thereof, which adds considerably to the gratification of those entrusted with the installment of such plants.

The Crocker-Wheeler Electric Company have made a great success of their derrick travelling cranes, etc., the number in use having increased very largely in the past year. Their own plant at Ampere is well equipped and will prove to be of great interest to manufacturers and the trade desiring further pointers.



10-Ton Derrick Crane at Iron Works of Messrs. Post & McCord, Brooklyn, N. Y. One size 10 C.-W. Single-Reduction Motor on Hoist and one size 3 C.-W. Motor on Trolley Travel.

NEW YORK ELECTRICAL SOCIETY.

In consequence of the illness of Prof. Sydney H. Short, and the fact that so many of the Society are engaged in active work on the Electrical Exhibition, it has been decided to give Prof. Short's lecture on "The Outlook of Heavy Electric Traction," during the Exhibition.

At the Electrical Exhibition there will be various demonstrations of scientific phenomena and principles by means of models and apparatus, which will be in more or less continuous operation. As the society has been entrusted with a great deal of the work of this kind it would like to secure from among its members the help of volunteers to take charge of various features from time to time; the duty will not be heavy, but will be made as light as possible

The first applications will be selected, preference being given, as far as possible, in case there be a large number of applicants, to students of educational institutions. The assignment to duty will be in the hands of a committee of the Society and the Exhibition Company, and the work of such members will be publicly recognized.

EXHIBIT OF HEBREW TECHNICAL INSTITUTE.

For some time past the Hebrew Technical Institute has made a great success of its instruction in the technical branches of electricity, as distinguished from the mere teaching in a manual or trade school. Evidence of the ability of the students under Mr. Ker will be given at the Exhibition, where opportunity is being afforded for an excellent display of the electrical engineering skill of the boys. Not only will a number of instruments be entered for the model-making competition, but these will be supplemented by other instruments and apparatus built by them to illustrate principles and phenomena. There will also be a complete small plant in operation lighting a small house. A collection of blue prints and photgraphs will also be included.

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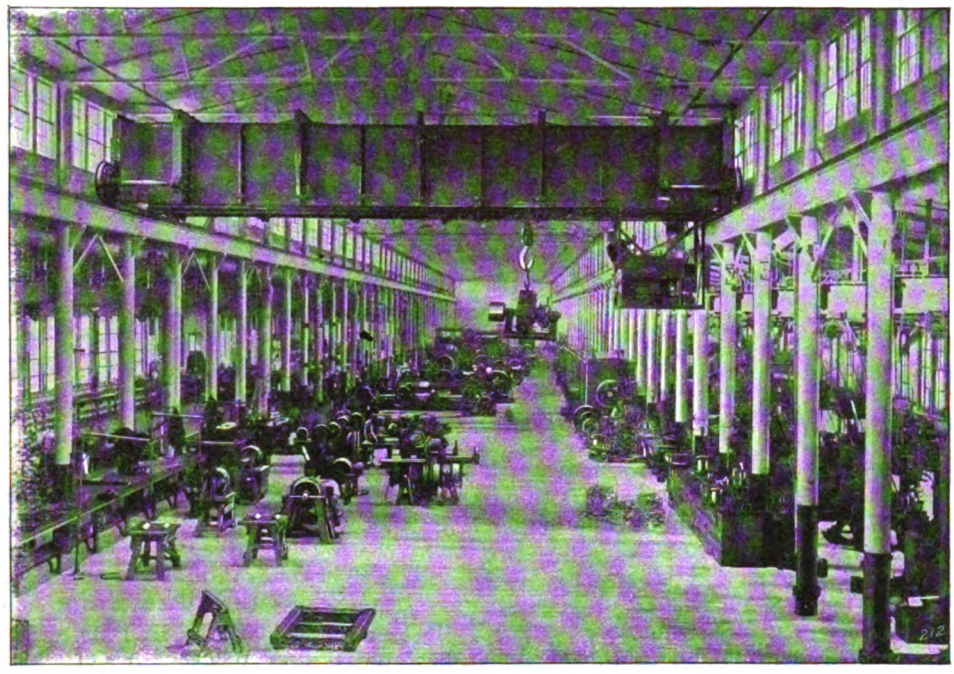
THE COMING TELEGRAPH TOURNAMENT AT THE ELECTRICAL SHOW.

TO TAKE PLACE MAY 13 AND 14.

The judges held a meeting at the Astor House on April 13th, among those present being Fred Catlin, T. J. Smith, J. B. Taltavall, H. W. Pope, George H. Guy, A. E. Sink, E. A. Leslie, W. D. Weaver, P. T. Brady, P. B. Delany, S. F. Austin, T. R. Taltavall and William Maver, Jr.

The meeting was called to order by Mr. Catlin, who was elected chairman. J. B. Taltavall was elected secretary. After some discussion it was decided that the conditions to govern the judges in their decisions, as printed in the circular which has been widely circulated, sufficiently covered the ground.



Section of Assembling Department, Crocker-Wheeler Works.

An executive committee was then appointed to take care of all matters embraced in the duties of the judges.

The executive committee, consisting of Fred Catlin, A. E. Sink, T. J. Smith, P. B. Delany and J. B. Taltavall, held a meeting immediately after the judges adjourned. Mr. T. J. Smith was appointed a committee to arrange for suitable phonographic records, and Mr. P. B. Delany to provide apparatus for chemical or other records not phonographic.

The executive committee then adjourned, to meet on April 21st.

Mr. A. E. Marr, of the Associated Press, an exceptionally good code operator, has been added to the list of judges.

The Smith-Premier Typewriter Company state that those living at a distance who desire to use their machine in the contests need not bring their typewriters with them to New York. Mr. W. H. Durphy, the New York manager of the company, is prepared to furnish all comers with typewriters. Mr. Fred E. Burnell, of New York, proposes to enter one or two events in the tournament, more with the idea of demonstrating the fact that telegraphers' paralysis is a curable disease, and giving telegraphers a practical demonstration of his complete cure by electricity itself.

Friday evening, May 13th, and Saturday afternoon and evening, May 14th, are the dates on which the tournament will take place.

THE WALKER CO., H. McL. Harding, Eastern manager, have moved to more desirable quarters in the Commercial Cable Building, 20 Broad street, N. Y.

INSULATION AND CONDUCTION.

(Continued from page 234.)

3. Conductivity in fluids.—The nature of the manner in which electricity is conducted in electrolytes has been very thoroughly worked out by Clausius, Arrhenius, Hittorff, Kohlrausch, Nernst Ostwald and others, and the work of these physicists has led to the linking together of results in a way which is simply marvellous. As the results can be obtained from works on physical chemistry, a very brief resumé is given.

The atoms of a solid are held together by the force of cohesion and driven apart by the hitting of the atoms on each other, due to the fact that they are in vibration, possessing kinetic energy proportional to the temperature. The molecule may also be pulled apart by the cohesive attractions of its atoms for other atoms. Whether a substance is a solid or a gas depends upon whether the fraction—

$$\frac{\text{Cohesive force of atoms for one another} + \text{external force}}{\text{Kinetic repulsion} + \text{cohesive attraction for other atoms,}}$$

is greater or less than unity. We can thus turn a substance into a gas in two ways, i. e., by increasing the kinetic energy of the atom by heating it, or by bringing it in contact with other atoms, when, if the sum of the terms in the denominator is greater than the numerator, it will dissolve.

We have to distinguish two kinds of linkages in solids, the cohesive force of the atoms for one another in uniting to form a molecule, and the attraction of the molecules for each other. The former generally is stronger than the latter; consequently we may have a substance which on being put into contact with a solvent will have its molecules pulled apart from one another but not its atoms. In the presence of another solvent, however, the second term may be sufficiently great to pull apart not only the molecules but also the atoms of the molecules. The substance is then said to be not only dissolved but disassociated. But dissolved substances give an osmotic suction per sq. cm. which is equal numerically to the kinetic pressure which the substance would have if it were turned into a gas at the same temperature and volume as the solution. A number of proofs of more or less validity have been given for this, but it seems to the writer to follow at once from the obvious fact that if we take a solid and heat it and dissolve it, the kinetic repul-

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sion must always equal the cohesive attraction plus the vapor pressure when equilibrium is reached.

This phenomenon of osmosis has been generally treated of as due to pressure and the dissolved substance to exercise a pressure equal to that which it would have if turned into a gas at the same temperature and volume. The writer (in the "Elec. Review, London, Nov. 27, 1891,) pointed out, as above, that the results were better explained by supposing that the solvent took up the cohesion of the solute, and that this got rid of the great difficulty of the disassociation theory, i. e., that solution was generally accompanied by heating. Recently this theory has been put forward by other well-known physicists. Prof. Poynting ("Phil. Mag.," Oct., 1896) has treated the subject mathematically, and whilst the mathematical reasoning cannot be considered conclusive, as Prof. Poynting himself states, yet, as he puts it, it shows "that it is not necessary to ascribe osmotic pressure to disassociation, but rather to association, or some kind of combination of salt and solvent." I have ventured therefore, in view of this fact, to do what I would not have done otherwise, i. e., to substitute my own conception of a suction for that of a pressure, otherwise making no change.

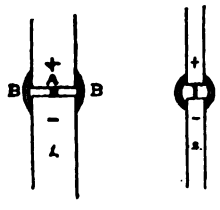

Fig. 4.

Fig. 5.

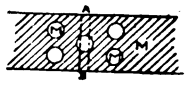

Fig. 6

In this way by measuring the osmotic suction we can tell whether a salt is disassociated or not; and it is found that only those salts which are disassociated can conduct electricity. The molecules split up generally into two parts, one charged with posititive, the other with negative electricity. These charged parts or ions when placed in an electro-static field move with a velocity proportional to the slope of potential and to the specific ability of each ion to move among the crowd of molecules of the solvent. Consequently the faster an ion can get along through the crowd of other molecules, i. e., the faster it can diffuse, the faster will the electricity be carried, and the greater the amount carried per second for a given slope of potential; also the greater the quantity of electricity carried per ion the greater the current. The total quantity carried will be the sum of that carried by each ion, so that by adding the velocity of the ions we get the total velocity with which the electricity is moving.

The conductivity of a solution is thus dependent upon the following:

1. How powerful the attraction of the molecules of the solvent is for the ions of the solute, for on this depends how much of the solute is disassociated, i. e., how many ions are set free to carry the current.

2. How fast the ions move.

3. What the valency of the ions is.

In designing insulations, the first is the important point. For from it we see that two good insulators mixed do not necessarily make a good insulator. A solid may dissolve in one substance and be an insulator in solution, but in another solvent may conduct quite well.

This is what makes the chief difference between fluid insulators, for practically all the fluids which are not simple elements, like mercury, have very high ohmic resistance, and all have practically about the same dielectric strength. The ohmic resistance of pure water is, according to Kohlrausch and Heydweiller, about one meghom per cubic centimetre, consequently on account of its non-inflammability and great specific heat, its great heat of vaporization and low boiling point, it would be a very valuable insulator for some types of apparatus were it not for the fact that it dissolves almost everything in slight proportions and splits them up into ions. Varnished paper will dissolve in some high resistance oils, forming a conducting solution.

C. Conductivity in Gases.—There is much evidence to show that conduction in gases is electrolytic, more especially J. J. Thomson's beautiful work on this subject. Also the fact that in air or CO_2, carbon is deposited on the negative pole, sometimes to the thickness of more than an inch in enclosed arc lamps, according to Marks, while in hydrogen or hydro-carbons in many instances the carbon is deposited on the positive carbon, would seem to favor this view. Also in its favor is Prof. Elihu Thomson's observation of the formation of copper "trees" in incandescent lamps with coppered filament joints. Against this is Schuster's observation that the metallic lines in the spectrum have a fairly high velocity, and also the general appearances of the arc, which looks as if something were going in one direction down its centre and something else back on the outside. Also there is one other phenomenon which looks as if it were convective. This is the fact that if we take a solid carbon and bring it nearer to a similar carbon while the current is passing, the resistance first decreases and then increases. This was I believe first pointed out by Mrs. Ayrton in her admirable paper on the subject. The reason of it has not I believe been given; it seems to be due to a necessity for circulation in the arc. If we have two carbons as in Fig. 4, at 1, the centre part of the current seems to flow all right, but the part B cannot flow unless the + carbon is very hot, and this is only cured by either increasing the current so as to heat the whole carbon up or by reducing the cross-section, as at 2 in Fig. 4. Whether a carbon is cored or not has nothing to do with this increase of resistance on the distance being shortened, as all that coring does is to diminish the cross-section of the carbon, and I have repeatedly found by actual test that the difficulty is entirely obviated by using carbons of × or — cross section, provided the greatest thickness at any point of the cross-section is less than that of the cored. The phenomenon is evidently analogous to the jumping back of the discharge in a Geissler tube when the electrodes are brought too close together. The theory of this was given by J. J. Thomson, and it was by applying this that I got over the difficulty with the carbons. A true arc can be run from a much lower voltage in open air than is generally supposed when the section of the carbon at any point is not more than $\frac{1}{100}$ cm. thick. On the whole, the evidence seems to be in favor of the belief that both convective and electrolytic discharges take place in air. The whole subject is very fully treated in J. J. Thomson's "Recent Researches in Electricity and Magnetism." There can be, in my opinion, very little doubt but that when a true electrolytic discharge takes place, as it does in a hot flame, the conductivity is proportional to the velocity of sound in the gas, though so far I am not aware that any experiments have been made on the subject. It is possible that in certain cases the elasticity itself may be a function of the slope in the electrostatic field. As the vacuum increases up to a certain point, the dielectric strength increases, and this point depends somewhat on the electrodes and voltages, and has led to the amusing result, that on the average every two years the discovery is announced that a vacuum is a good conductor. Above this, the discharge appears to get more and more convective, and a fact may be stated which I have not seen mentioned, i. e., that the largest quantity of X-rays is not got from a tube unless the path of the positive par-

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ticles back to the cathode is blocked up as much as possible. An experimental tube made by Mr. Meadowcroft for the writer last spring, in which there is a small tube running from the back of the anode to the back of the cathode which can be blocked up by tilting it, shows this very nicely.

As regards the electrolytic discharge, this can only take place when the gas is disassociated by heat or by a strong slope of potential. To the convective discharge the same remarks apply as to the convective discharge in gases. At ordinary pressures the only gases which allow a discharge to pass easily are helium, argon and possibly that unknown gas whose spectrum we see in the light of the Aurora Borealis. Helium, as shown by Ramsey, behaves at ordinary pressure much as air at low pressure, and a spark will jump through it for about thirty times the distance it will through air at the same pressure, when the pressure of both approximates that of the atmosphere.

Having got rid of the theory which was necessary in order to give opportunity to condense later, and which has led me to wonder if it were ever possible to find the pleasing mean between the conciseness of the Carpenter and the discursiveness of the Walrus, we shall take up the practical part of the subject.

(To be continued.)

HISTORICAL TABLEAUX AT ELECTRICAL SHOW

A series of eight illustrative and historical wax tableaux (designed to mark some of the successive stages of electrical development), prepared by Dr. Park Benjamin, Prof. F. B. Crocker and Mr. T. C. Martin, executed and arranged by the Eden Musee Company, will be a feature in the Concert Hall.

The series will include the First Recognition of an Electric Effect, when the Syrian woman, centuries before our era, wonderingly perceived light objects flying to her amber spindle; the Mariner's Compass, ascribed to the Chinese and Italians, but probably to be credited to the Finns, in the 11th century; the Earth a Great Magnet—William Gilbert explaining the Terella to Queen Elizabeth, 1600; the First Conductors or Circuits; Stephen Gray, a Charter-house pensioner in London (1720) experimenting on the Conduction of Electricity; the Leyden Jar, showing the bottling of electricity and the terrible shock to Dean Von Kleist, Canon of the Cathedral in Cumin, in Pomerania, 1746; the Identity of Lightning and Electricity—when Benjamin Franklin drew down the lightning from the skies, 1752; the Beginnings of the Modern Primary Battery or Voltaic Cell, with Galvani's famous frog experiment, 1791; and the Beginnings of Modern Dynamo-Electric Machinery, showing Michael Faraday's famous experiment, 1831.

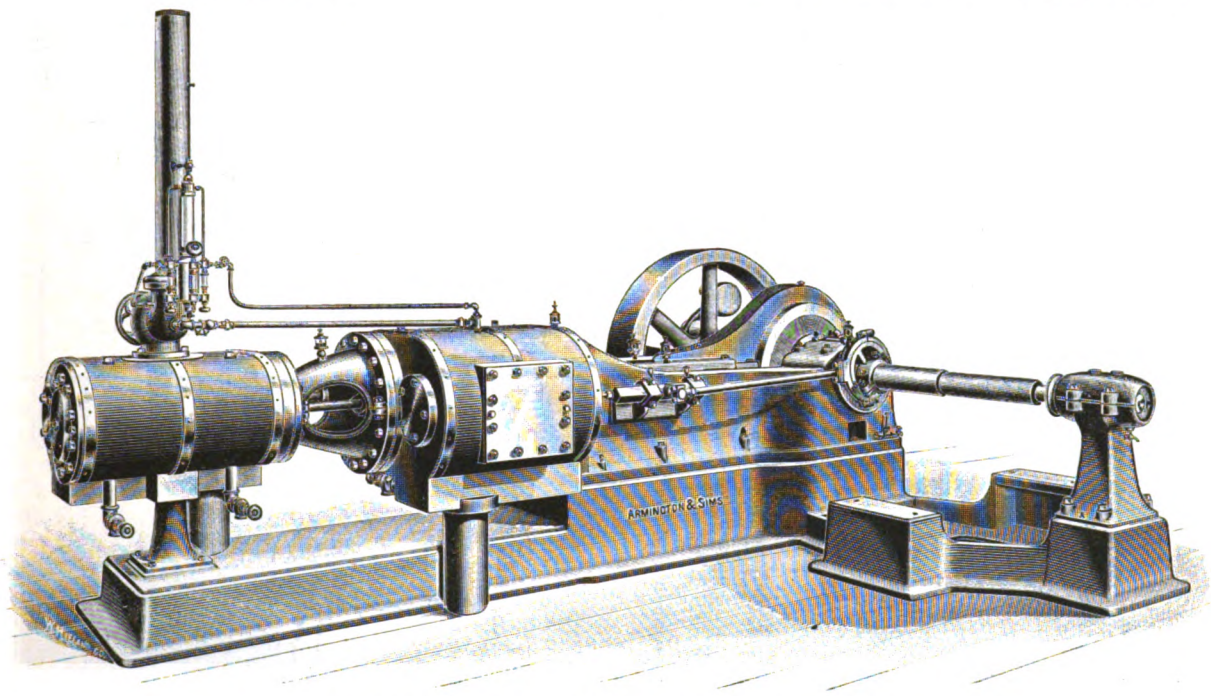
These tableaux are accompanied by a selection from Dr. Park Benjamin's celebrated library of early philosophical, technical and electrical books, each illustrating some feature or stage of electrical evolutions.

Mr. Chas Chamberlain has been placed in charge of the Press Bureau of the Electrical Exposition.

HIGH-SPEED ENGINES FOR ELECTRIC LIGHTING.

The development of electric lighting has exercised a wonderful influence over the design and construction of steam engines. The valve gear with its modern improvements, the governor with its all but human intelligence, and the strength and lightness of the engine as a whole shows conclusively that it can well perform its function in driving the dynamo uniformly and economically for electric lighting.

The Armington and Sims high-speed engine represents a combination of improvements which make its reputation the highest and its serviceability widely known. Such improvements as the self-adjusting cylindrical or piston valve, the Ritz inertia governor and certain oiling devices are included among the list. For electric railway service, which is of the severest character, engines of giant mould have been built, which meet great external variations without the least tremor. The operating parts of the Armington and Sims engine may be readily inspected without inconvenience, and all parts apt to wear are capable of further and immediate adjustment. The above illustrations relate to direct-connected plants, either for shipboard or land service. Dynamos of 150 K. W. capacity or less are provided with engines having an extended shaft, outbored bearing and an extended sub-base. For dynamos larger than 150 K. W., engines direct-connected to the same are built with separate cast-iron base-blocks for dynamo instead of extended sub-base.



250 H.-P. Tandem Compound Engine, Direct-Connected Type.

The Armington and Sims engines are so constructed that connection may be made to two dynamos at the same time, each end of the shaft driving a generator. "In this arrangement the governor is mounted upon a slotted

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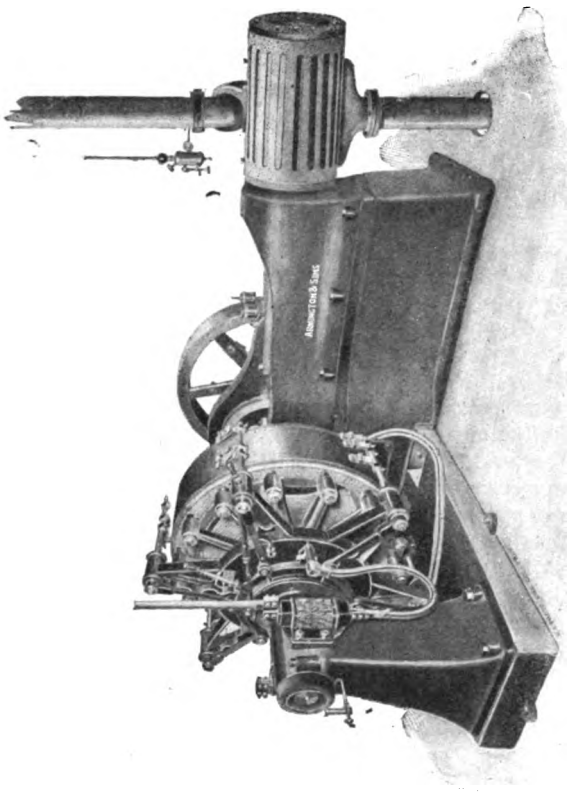
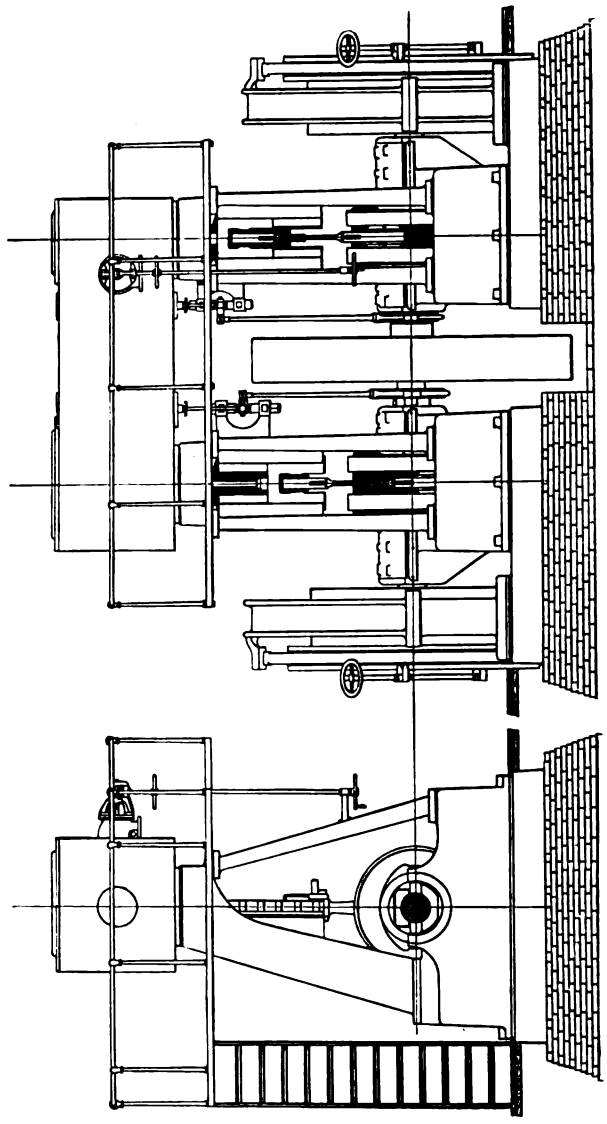
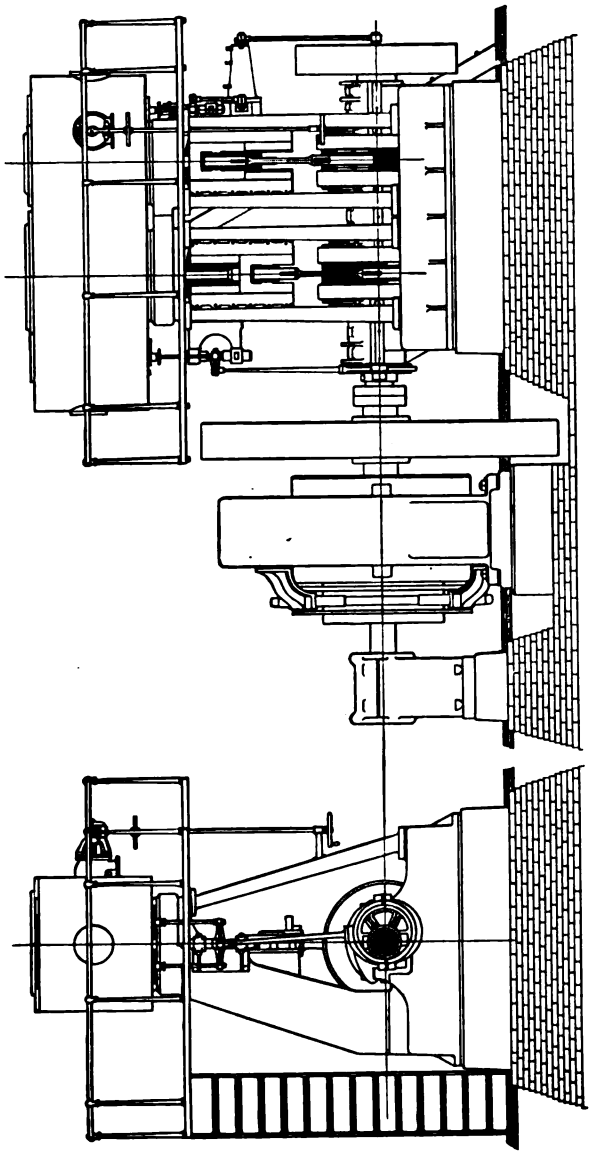


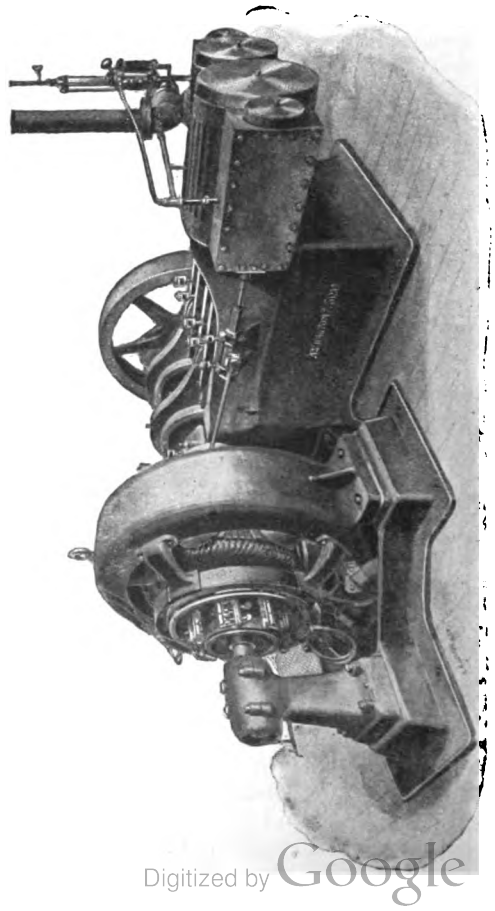
160 H.-P. Simple Horizontal Engine, Direct-Connected to 100 K.-W. Dynamo



750 H.-P. Cross Compound Vertical Engine Direct-Connected to Two 250 K.-W. Dynamo.



750 H.-P. Cross Compound Vertical Engine, Direct-Connected to 500 K.-W. Dynamo.



120 H.-P. Cross Compound Engine Direct-Connected to 75 K.-W. Dynamo.

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The Electrical Age.

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PROPERTIES OF CELLULOSE.

The investigations of science frequently bring to light new properties in old substances. Regarded from a general standpoint, cellulose bids fair in the future to find its application as part of the equipment of war vessels and as a means that cannot be despised of insulating high potentials. In the "Yale Scientific Monthly," of November, 1897, Mr. E. L. Freeland, in an article entitled "A New Form of Cellulose," explains its use as a means of preventing the sinking of cruisers whose armor would be penetrated by shot. For this purpose cocoa-cellulose, as well as the pith of cornstalks, has been used. Corn pith is obtained from grist mills as a sort of by-product, being exceedingly cheap in consequence and readily obtained. Cellulose used for purely electrical purposes exists, according to Reginald A. Fessenden, in an article on "Insulation and Conduction," read before the American Institute of Electrical Engineers, in two states, that is to say, the pure cellulose.

A condenser made of this material and with pure parraffine, according to Fessenden, will stand two hundred and fifty volts per thousandth of an inch when the dielectric is less than one one-hundredth of an inch, and at a higher rate for greater thicknesses when the effect of small defects is not serious. There is a suggestion contained within the limits of this argument which might find its practical application in the insulation of certain heavy wires and cables. The cheapness and comparative ease with which it can be used should appeal very strongly to the practical engineer, to such an extent, we hope, that they will follow the recommendations of Mr. Fessenden and find out where it can be applied or used to the greatest advantage.

THE ENCHANTED ARMOR OF SCIENCE.

The belief of the most luminous minds of this period is to the effect that war inits most violent phases has become merely the antagonism of two nations armed with scientifically constructed means of onslaught and defence. In other words, the armor with which science clothes the military and naval forces of a nation places it upon the list of powers according to the protection it affords.

The "Spectator," of London, publishes the following note, which clearly shows the trend of modern thought in that country and will certainly be regarded with pleasure by those appreciating a short and concise eulogy of our own abilities: "American naval officers have in them qualities which Spanish naval officers have not, and for which mere courage, however gallant, is no sufficient substitute, and we think that when the two fleets clash in earnest the American flag will not be the one to be struck. The fight may be a stubborn one, but it will be a fight between a brave man with his weapons only and a brave man also with weapons, but clad in an enchanted armor of scientific knowledge. The American will have fifty devices where the Spaniard has five."

The use of the Fiske Range Finder has added greatly to the strength of war-ships by supplying them with a device for accurately determining the distance between one vessel and another and the proper angle at which a gun must be pointed in order to land its shot. The use of torpedo boats, sub-marine mines, etc., has greatly aided those interested in the modern art of destruction. These appliances will in the future exercise a great moral influence on the aspirations of those that desire war, and if for no other reason than this, the work of improving coast defences and constructing devices of an electrical or mechanical nature for attack and defence should go on uninterruptedly.

STEEL.

Steel is not cast into crank shafts, gear wheels, locomotive driving centres and any number of castings which need strength. It is used a great deal in electrical castings where high magnetic permeability is needed. A steel casting has about twice the magnetic permeability that an iron casting has. Therefore steel castings weigh about half as much as iron castings of the same magnetic permeability. The chief objection to steel castings is that they cost about three times as much as iron castings. But in these days of progress, weight is being noted as much as price, and steel castings are being used very extensively in all classes of machinery where iron castings of the same strength would be too cumbersome. The above statement was made by Robert D. Reynolds and clearly indicates the position the manufacturing world is occupying in regard to the use of steel.

The present perfection attained by manufacturers of electrical machinery can be attributed, first, to their increased knowledge of the design and construction of dynamo electric machinery, and, secondly, to the advantages offered by the use of a highly permeable and easily moulded material.

THE TELEPHONE AT THE EXPOSITION.

The New York Telephone Company will make an exhibit illustrative of the operation of the telephone system of this city. There will be shown specimens of the latest styles of telephone apparatus and silence booths for the equipment of public and private telephone stations. Pretty nearly everybody is more or less directly interested in the telephone service nowadays, though few know just how it works. The New York Telephone Company's exhibit will give visitors to the show a very fair idea of just how the serviee does work, as part of the exhibit will be a switchboard in actual operation, which will serve stations at various points in the Exposition Building. Trunk

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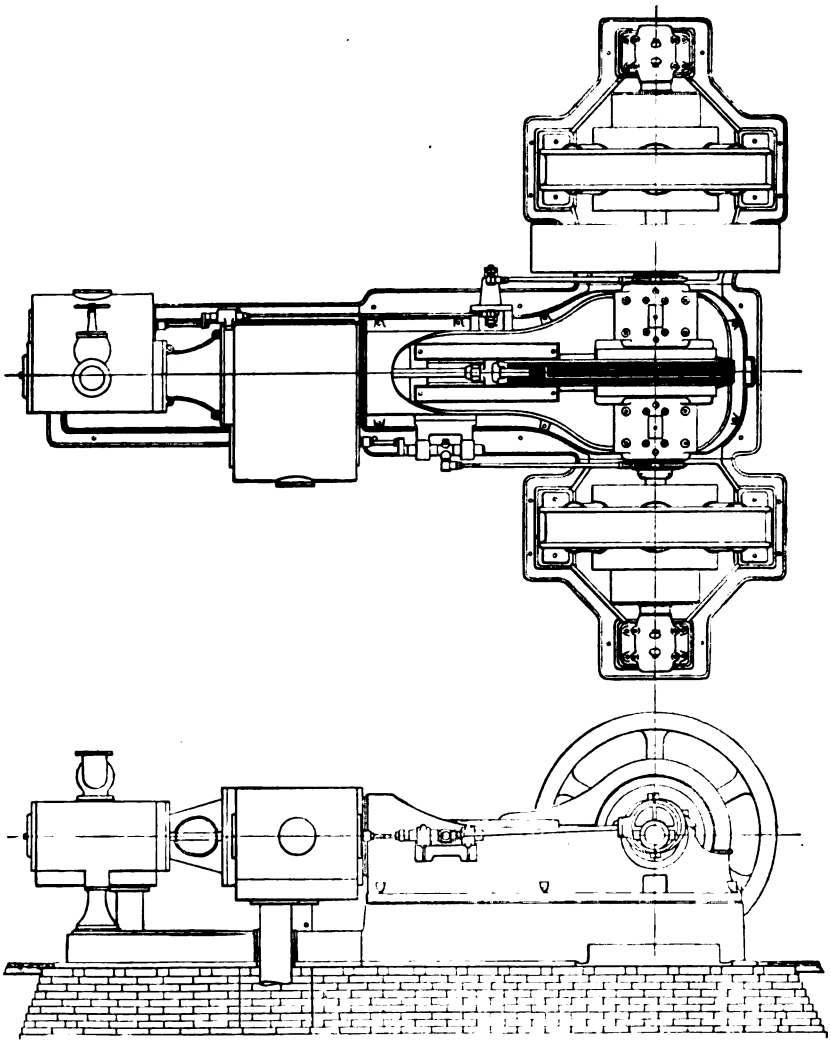
lines will run from the Exposition switchboard to one of the main exchanges, so that the stations in the Exposition may not only be connected directly to each other, but also to any station in the city or in any part of the country reached by the telephone systems of the New York, the New York and New Jersey and the American Telephone and Telegraph Company.

In short, this part of the exhibit will be a working specimen of the Private Branch Exchange System which has been so largely adopted by big business houses of all classes since its introduction by the New York Telephone Company a year or two ago.

Arrangements are also making for a separate telephone feature, which will be the transmission of music from various New York theatres and out-of-town points every evening during the month of the Exposition. The Exposition Company, the American Telephone and Telegraph Company and the New York Telephone Company are working jointly in the production of this attraction, which is sure to be popular with the general public.



200 H.-P. Tandem Compound Engine, Direct-Connected to Two 95 K.-W. Dynamos.

(Continued from page 243.)

eccentric working across the shaft and a roller bearing to reduce the friction to a minimum." About 5,100 Armington and Sims engines are in operation, the indicator cards of each one showing high efficiency and necessarily economical operation for changes of load.

Electric lighting puts an engine to a severe test, which has not in any way diminished since later and larger plants have been installed by electric railway, light and power companies. A large percentage of these are operated by Armington and Sims engines, which, serving as motive power for these plants, have proved themselves well worthy of the name they bear in every particular. The Armington and Sims Company build their engines in Providence, R. I., to which correspondence may be directed for information of a special nature.

THE DEVELOPMENT OF ELECTRICAL SCIENCE.

(Continued from page 226.)

In 1827 the celebrated law giving the relation between e. m. f. resistance and current was published by Ohm in a paper on the mathematical theory of the galvanic circuit. The theory has been sometimes criticised, but there seems to be absolute certainty that the law is almost exact, and it has proved of the greatest importance in the further development of the subject of electric measurements.

The subject had, about the middle of the century, reached a stage in which it was possible to develop almost completely the mathematical theory as we now have it. Most of the work since Faraday's time has been directed towards quantitative measurements and the furnishing of exact data to answer questions as to how much in various cases. F. E. Neumann discovered what he called the potential function (now called the coefficient of self and mutual induction) of one current on another, and on itself, and succeeded in giving a theory of induction which was in accordance with the experimental laws. The laws were afterwards experimentally verified by Weber.

In 1849 the experiments of Kirchoff on the absolute value of the current induced in one circuit by another, and in the same year Edlund's experiments on self and mutual induction, are important. In 1851 Helmholtz gave a mathematical theory of this part of the subject, which he supplemented with an experimental verification.

One of the most important of the series of experiments made by Henry was on the oscillatory character of the discharge from a Leyden jar. This he discovered from the effect of the discharge on a steel needle surrounded by a coil, through which the current was made to pass. The results of these experiments were communicated to

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the A. A. A. S. in 1850, but he knew of the effect much earlier, certainly in 1841. Previously the anomalous behavior of the discharge of a jar when used to magnetize steel needles had been noticed, but was attributed, as I believe, to some peculiarity of the steel. Henry was the first to appreciate the true reason, although he could hardly at that time be expected to see the great importance of his discovery.

Helmholtz, in 1847, suggests that the discharge of Leyden jars may be of the nature of a backward and forward movement.

There is a curious parallelism in the work of several investigators about this time, and particularly in that of Helmholtz and Thomson. In the "Philosophical Magazine" for 1855 there is a paper by Professor W. Thomson (Kelvin) in which the theory of the discharge of a Leyden jar is discussed and the prediction made that under certain specified conditions the discharge must be oscillatory. A number of similar papers, going back to 1848, treat of similar subjects. Henry's results do not appear to have become generally known, and we find the verification of Thomson's prediction in 1857 by Feddersen. A number of other physicists have investigated the subject, the work of Schiller being of particular value. The recent applications will be referred to later.

The mathematical theory of electrostatics and magnetism was greatly extended about this time by Thomson and others, and received its most complete statement at the hands of Maxwell in his papers read before the Royal Society and in his book, published in 1873, but still the standard of reference. Very little has since been discovered which was not foreshadowed by Maxwell's theory or contained in his equations, which have been found general enough to cover almost everything, although experiment has generally been necessary to suggest the consequences of the theory.

The practical applications of electricity have played a most important part in the development of the subject during the last sixty years. Indeed, a great part of the work of these years has had some practical application in view. One of the first of these practical applications was that of telegraphy.

The telegraph, being one of the earliest of the practical developments, naturally had a great effect in stimulating the advance in knowledge of electricity, and hence I give a somewhat fuller sketch of the early history, that space will permit for the later applications.

The discovery of Stephen Gray, in 1829, that the electrical influence could be conveyed to a distance by means of an insulated wire, is probably the first of direct influence in connection with telegraphy. As a result of this discovery and the investigations which followed it, a considerable number of proposals were made as to the use of the electrical force for the transmission of intelligence. The first of these of which I have found any record was made in 1753 by Charles Morrison, a Scotchman, and then followed other proposals for electrostatic telegraphs by Bozolus in 1767, by Le Sage in 1774, by Lomond in 1787, by Betancourt in the same year, by Reizen in 1794, by Cavalla in 1795, and by Ronalds in 1816.

The discovery of voltaic electricity, and most directly the discovery of Nicholson and Carlisle of electrolysis, gave rise to another group of proposals for the application of this discovery to the production of telegraphy. Among those may be mentioned that of Sommering in 1809, of Coxe in 1810, and of Sharpe in 1813. In more recent years, of course, the same application appears in the chemical telegraphs, some of which are capable of giving very satisfactory results and great speed.

The discovery which had the greatest influence on the development of telegraphy was that of Oersted, supplemented by the work of Schweigger and Ampere. Ampere proposed a multiple-wire telegraph with galvanoscope indicators in 1820, and a modification was constructed by Ritchie. A single-circuit telegraph of this character was invented by Tribaoillet, but didn't come into use. In 1832 Schilling's five-needle telegraph appeared, and he, also, used a single-needle instrument, but his early death stopped further progress. In 1833 Schilling's telegraph was developed, to some extent, by Gauss and Weber, who used it for experimental purposes. The following quotation, referring to Gauss and Weber's telegraph, from "Poggendorf's Annalen," is of considerable historical interest:

"There is, in connection with these arrangements, a great and until now in its way novel project, for which we are indebted to Professor Weber. This gentleman erected, during the past year, a double-wire line over the houses of the town (Gottingen), from the Physical Cabinet to the Observatory, and lately a continuation from the latter building to the Magnetic Observatory. Thus, an immense galvanic chain is formed, in which the galvanic current, the two multipliers at the ends being included, has to travel a distance of nearly 9,000 (Prussian) feet. The line wire is mostly of copper, of that known as 'No. 3,' of which one meter weighs eight grammes. The wire of the multipliers in the Magnetic Observatory is of copper, 'No. 14,' silvered, and of which one meter weighs 2.6 grammes. This arrangement promises to offer opportunities for a number of interesting experiments. We regard, not without admiration, how a single pair of plates, brought into contact at the farther end, instantaneously communicate a movement to the magnetic bar, which is deflected at once for over a thousand divisions of the scale." Further on in the same paper: "The ease with which the manipulator has the magnetic needle in his command, by means of the communicator, had a year ago suggested experiments of an application to telegraphic signalling, which, with whole words and even short sentences, completely succeeded. There is no doubt that it would be possible to arrange an uninterrupted telegraph communication in the same way between two places at a considerable number of miles distance from each other."

(To be continued.)

DEMONSTRATING THE USE OF SUBMARINE MINES AT THE ELECTRICAL SHOW.

Major H. J. Smith, of Pompton, N. J., one of the best known experts in the world in submarine explosives, mines, etc., has very kindly tendered his services to the Exhibition Management for the demonstration in a special tank of the manner in which harbors are protected, ships blown up, etc., and some of his ingenious apparatus has been loaned for this interesting work by Mr. C. McLaughlin, of J. H. Bunnell & Co. This will probably be one of the most attractive features af the show.

ELECTRO-MAGNETIC INDUCTION.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

The many phenomena brought to our notice by the action of a current are still more wonderful when the current acts upon another. It is strange that today we are just waking up to the fact that many of the effects around us are due to the presence of an invisible and extremely fine atmosphere called ether. It is not necessary to know what ether is in studying its effects, only that its presence be remembered, and its qualities, as far as they are known. In studying the principles of electro-magnetic induction we are compelled to look upon the subject as we would gravitation; that is, in each case one body is capable of affecting the other without any visible material between. But we know that one exists,

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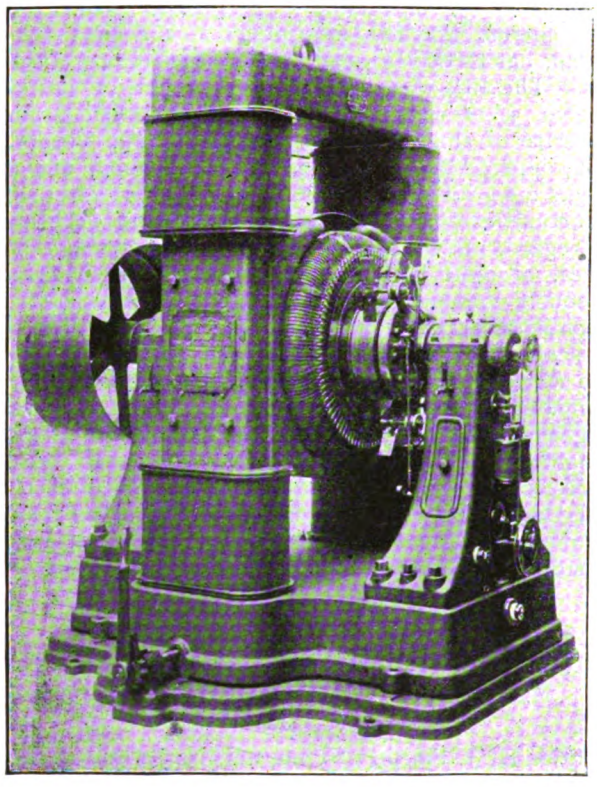
as well as we know that air, or hydrogen and oxygen are realities. It is always surprising to see one body influence another, as, for instance, a magnet a piece of iron. Yet the old effect of the earth on a stone is constantly forgotten Familiarity with certain electrical experiments makes them lose novelty and become accepted with unconcern as the most prosaic truth to be found.

A coil of wire carrying a current becomes surrounded with magnetism. If the current changes the magnetism does likewise, and even the minutest variation is distinguishable at once. Another coil in the vicinity of the first can only be affected if these changes occur. Either the current must increase in the first coil or it must decrease; in either case, the second coil produces a current. A steady and uniform current in the first coil produces



Dynamo Producing Pulsating Current.

no lasting effect in the second. But when the current is started the second coil shows it, and when it is stopped. Each of these changes, however, mean an increase or decrease of current in the first coil, and it is in these changes that the phenomena of electro-magnetic induction occur when another coil is present.

Currents may be divided, according to their nature, into four kinds at least:

Uniform current,
Pulsating current,
Alternating current,
Interrupted current.

The coil receiving these currents will affect any neighboring coil in the same way. If it be connected to a galvanometer, the pulsations and changes can be clearly noted. The circumstances governing the intensity of this effect are deeply interesting. It is a department of science which touches upon a new field of facts—the study of action at a distance.

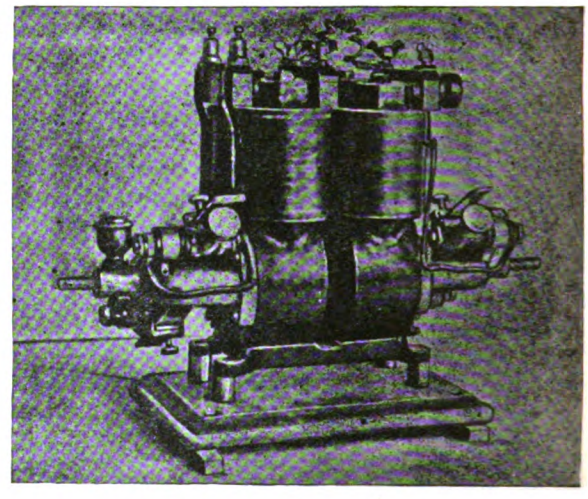
The ordinary lighting current is due to a series of pulsations, so small, however, that they appear to blend into one continuous whole. The arc-light current is a true pulsation, a rise and fall, of the current strength, but a flow which, whether weak or strong, does not change in direction. The remaining current used in commercial lighting is the alternating or sinusoidal current. It derives its name from the peculiar growth, decrease and reversal in direction. It may be observed that entirely different systems of lighting are built upon this difference between each. In the last, transforming devices are required, which have opened up a new field in the transmission and distribution of power.

The entire principle of electro-magnetic induction depends upon the mutual reaction occurring between a wire and a field of magnetism. Either may be moved in the neighborhood of the other and an electromotive force will be excited.

It is important that this fact be received as an absolute truth, which in any case can be depended upon with the same surety that gravitation, or the revolution of the earth, is relied upon.

An invincible principle like this is the mirror with which we reflect all other truths; it is the foundation—the stepping stone—without which further progress is impossible.

It may be understood from the last statement that either a wire moves in a magnetic field, or the field is moved in the neighborhood of the wire. We can also add that both may take place and still produce the effects spoken of. By moving a wire and a magnetic field so that they mutually interact, we are simply transferring the power required for that motion to the wire. The



Continuous Current Transformer.

elastic material required for the transference of this energy is the magnetic field; the strained ether. In what direction does the current flow, and how can it be increased or diminished by this means? In other words, what limitations are there which give but a circumscribed value to the effects of all electro-magnetic relations?

The E. M. F. developed in any case depends upon the number of lines of force cut per second. If a coil is carrying a current and thereby generating a magnetic field, another coil in its vicinity will have excited in it a potential difference of 1 volt if it is moved across the streaming lines of force so that its turns and the magnetie lines give a product of 100,000,000 per second.

Supposing the coil to have ten turns and the field proceeding from the other coil to equal 100,000 lines of force. To excite one volt the product of 100,000,000 must be sustained in a second. At present, with but one move of the coil, only 100,000 lines of force are cut. Therefore, the coil must be moved ten times in a second to generate one volt.

In developing this principle, the same basis is taken that all electro-magnetic phenomena consist merely of interactions between a magnetic field and a coil.

For commercial purposes it is necessary that we should know the exact value of the E. M. F. developed with a given number of lines of force and turns.

In all dynamos this first conclusion practically determines the size of the machine. By following this lucid

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principle still further, the great department of alternating current machinery may be investigated. We have to deal in this case with a series of special devices which have, because of their peculiar nature, successfully resisted all attempts to usurp them. Were it not for the ease of transformation, the life of alternating-current systems would be very short.

But in this fact lies its strength; it is simple and convenient and in certain cases most economical. The transformer of an alternating-current system consists of a complete magnetic circuit and two coils. A ring of laminated Swedish iron with a coil on each side comprises the total apparatus.

The iron is called the frame of the transformer and the two coils, the

Primary, and
Secondary.

The Primary.—This coil is usually of finer wire than the other. It is the one which receives the current direct from the dynamo and turns it into magnetic energy. It must be carefully insulated from the iron frame and the other coil. In daily practice the primary receives anywhere from 1,000 to 2,000 volts; its function is to magnetize and demagnetize the iron of the frame. For this purpose the coil is specially designed, because it generates a lot of heat when these rapid reversals occur. The primary is made with the proper radiating surface to admit of the rapid emission of heat. It is wrapped around in several layers of insulating tape and in some cases dipped in oil and kept there. The resistance in ohms of the primary is not the only factor which prevents the current from the dynamo injuring it. There is a back electromotive force, called self-induction, which holds the dynamo pressure in restraint. Its full effect is only felt when the secondary is supplying its full number of lamps with current. As an automatic valve, it is unequalled in its unfailing action at all times and under all circumstances. Were it not for the presence of this invisible regulator, the use of transformers could only be carried on with great difficulty. When the current flows into the primary the magnetized coil at once affects the secondary and causes it to generate an E. M. F.

The Secondary.—The principle elucidated now comes into direct application. The coil has been magnetized for an instant. Another coil wrapped around the iron in a similar manner to the primary is thus subjected to the influence of those lines of force the primary has just generated. If 100,000,000 of these lines of magnetic force sweep through the coil but once in a second, and the secondary consists of only one turn, the pressure developed in it will equal one volt. The design of a transformer hangs upon this fact.

QUESTIONS FOR REVIEW.

(1) In what medium does electro-magnetic induction occur?

(2) By what means is a current excited in an adjacent coil?

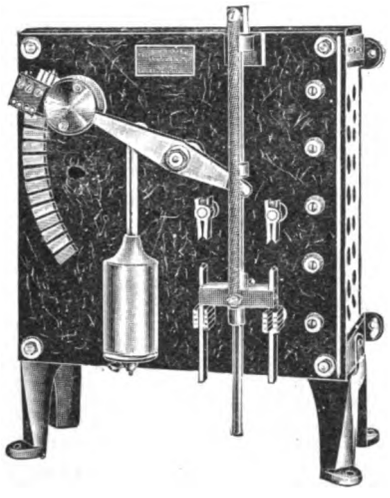
(3) How may currents be divided?

(4) Upon what does the E. M. F. developed in a coil depend?

(5) What parts are there to a transformer?

THE GRAVITY MOTOR CONTROLLER.

In offering this device to the trade, the Electrical Appliance Company, of 27 Thames street, New York, call their attention to the following salient points in its design: First, its remarkable simplicity in principle of design, small number of parts and accessibility to repair. Second, its durability, which in its working parts insures excellent wear. Special attention is called to the contacts, and the use of an exterior, non-conducting device for securing tension and the best of contact. The resistance in this arrangement will last and can be readily taken apart and replaced anywhere. The device itself can be easily attached to belted elevators by making rod connections direct from belt-shifting wheel or wheel operated from same.



Gravity Motor Controller.

There are three methods of using this contrivance: First, for starting an elevator and motor simultaneously; second, for starting the motor in advance of elevator, but still retaining automatic cut-off feature. With this method the automatic cut-off can be used or not, according to conditions. The above is changeable in a second, so as to permit motor to run independent of elevator; for instance, where the motor operates a pump, etc., for a portion of the day. Third, the above device is used for starting and stopping the motor independent of the elevator.

The Electrical Appliance Company have in course of construction a special controller and reverse switch for direct-connected elevator. The gravity motor controllers are made in sizes varying from three to fifty horse power for controlling elevators, motors, pumps, presses, etc. The remarkable success met with so far is an assurance of a heavy trade and rapid development.

Mr. G. A. Nisbet, the general manager of the company, is a man of wide experience in the electrical business, and very popular among the trade.

ELECTRICAL CONSTRUCTION & SUPPLY CO., formerly of 120 Liberty street, are nicely settled in their new quarters, 27 Thames street, N. Y. They have a fine repair shop and assembling room; also office and salesrooms. They make the well-known Kinsman Enclosed Arc Lamp; make a specialty of construction, wire, etc.

Petoskey, Mich.—D. D. Whitten, City Clerk, may give information concerning construction of new $8,500 electric-light plant.

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lectric Show, as we are going to press, is looming up into beautiful proportions. The decorations of the interior will be the most attractive the Garden has ever seen. The Edison Illuminating Company will make the Garden glow with electric light and their beautiful colonnaded exhibit will be worth the price of admission to see it. The beautiful exhibit containing the artificial vacuum tube, daylight system, under Mr. Moore's supervision, will be the attraction of visitors. A large number of exhibits were well under way, so that the Electrical Show, as it appears today, will be the greatest exhibition ever given in the Garden.

THE TELEGRAPH TOURNAMENT.

Signs are already visible of the keen spirit of rivalry which has been aroused in telegraphic circles by the announcement of the coming tournament. Already the cracks in many cities, both in the States and in Canada, are getting themselves into training. Some of the Montreal operators have written to ask whether they will have the same show as their American competitors. The reply they received assured them that they would have an open field and fair play, and they are now busy getting their contingent in racing form. In other cities, such for instance as Chicago and Philadelphia, the telegraphic fraternities are uniting to raise additional prizes to be given to the successful contestant from their city at the tournament.

The complete list of judges includes the names of—

A. S. Brown, Western Union Telegraph Co.
Francis W. Jones, Postal Telegraph Co.
A. E. Sink, Manager Western Union Telegraph Co.
Chas Shirley, Manager Postal Telegraph Co.
Geo. H. Usher, Supt. Postal Telegraph Co.
D. B. Mitchell, Manager Race Bureau—Western Union Telegraph Co.
Minor M. Davis, Traffic Manager, Postal Tel. Co.
Gardner Irving, Manager Commercial News Dept., Western Union Telegraph Co.
S. F. Austin, Commercial Cable Co.
P. J. Tierney, Manager Central Cable Co.
F. F. Norton and S. A. Coleman, Chief Operators, Postal Telegraph Co.
E. F. Cummings, Night Manager Western Union Telegraph Co.
Edwin F. Howell, Sec. Serial Loan Association.
E. T. Baberie, Postal Tel. Co.
Chas. Thom, Chief of Quadruplex Dept. Western Union.
E. H. Cox, Manager, and E. W. H. Cogley, Asst. Supt. Associated Press.
Thos. R. Taltavall, Editor Electrical World.
E. A. Leslie, Manhattan Electric Light Co.
J. H. Bunnell, Electrical Manufacturer.
H. W. Pope, Telephone Supt.
Wm. Maver, Jr., Electrical Expert.
Robt. W. Martin, Cable Editor N. Y. Sun.
P. B. Delany, Telegraph Expert.
Edward H. Johnson and Thos. J. Smith, Electrical Manufacturer.
Judges of Press Code: Ed. H. Curlette and P. T. Brady.

All the judges are expert telegraphers. The selection has been so carefully made, and the list includes so many men in the front of the electrical as well as the telegraphic industry, that every contestant may be assured that his individual interests will be protected. Phonographic and other records of each transmission will be made, so that in the event of any dispute the work may be reproduced.

Thomas A. Edison, Jr.'s exhibit will be one of the main attractions of the Show.

Elmer R. Morris and F. A. La Roche Company were arranging their beautiful exhibits as we go to press.

The Ward Electric Supply and Construction Co., 39-41 Ann street, New York City, have received the contract for installing the wires, mains and cables for the Electrical Show, and also for some of the private exhibits.

MR. REYNOLDS, the former steward of the old Electric Club, is managing the Manhattan Hotel and Restaurant, 1281 Broadway. It has been refitted and was opened April 18th. Messrs. Holloway & Irish are putting in the electric plant, dynamos, electric fans, lights, etc. Mr. Reynolds invites the profession to call.

J. Jones & Son, 64 Cortlandt street, New York, manufacturers and supply dealers in electrical goods of all kinds, will have one of the finest exhibits at the Electric Show. It is opposite the Edison Illuminating Company exhibit, and next to Thomas A. Edison, Jr.'s, beautiful booth. The back of the exhibit will contain a rich white mahogany board with panel work, studded with novel fixtures and lighting effects; the centre is a plush oblong design containing the name of the firm formed by small incandescent lamps on a blue plush ground. This will form the back of the exhibit. A handsome marble switchboard with all appliances on one side, and panels and supplies of all kinds made by the firm will form the opposite side of the exhibit. If you miss everything else, you cannot pass this exhibit by.

Faries Manufacturing Company, No. 136 Liberty street, New York, will exhibit at the Electrical Exhibition, Madison Square Garden, a general line of their goods, such as the Universal Electric Lamp Holders and Aluminum and Steel Electric Lamp Shades; also their Fire and Water Tube Boiler Cleaners. The exhibit will be located on the 27th street side of the Garden, on the promenade.

Syracuse, N. Y.—W. K. Niver has made application for a franchise to build an electric railway.

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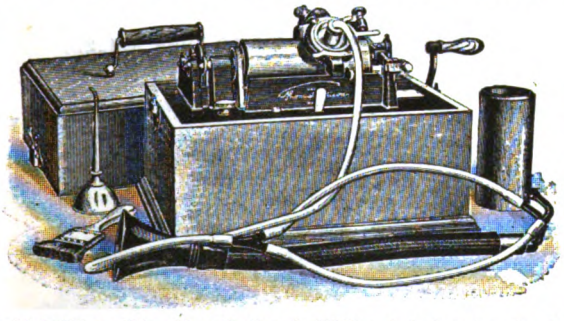

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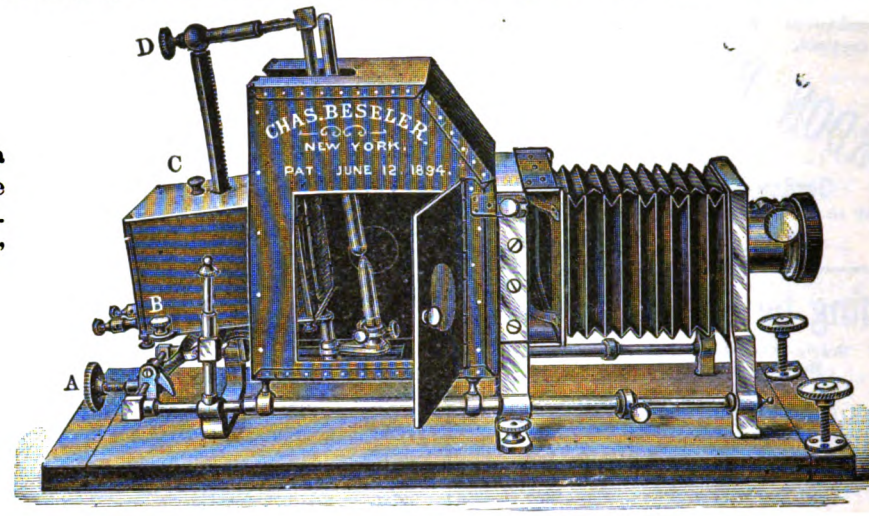

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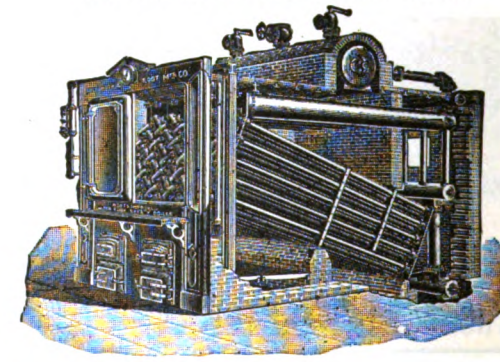

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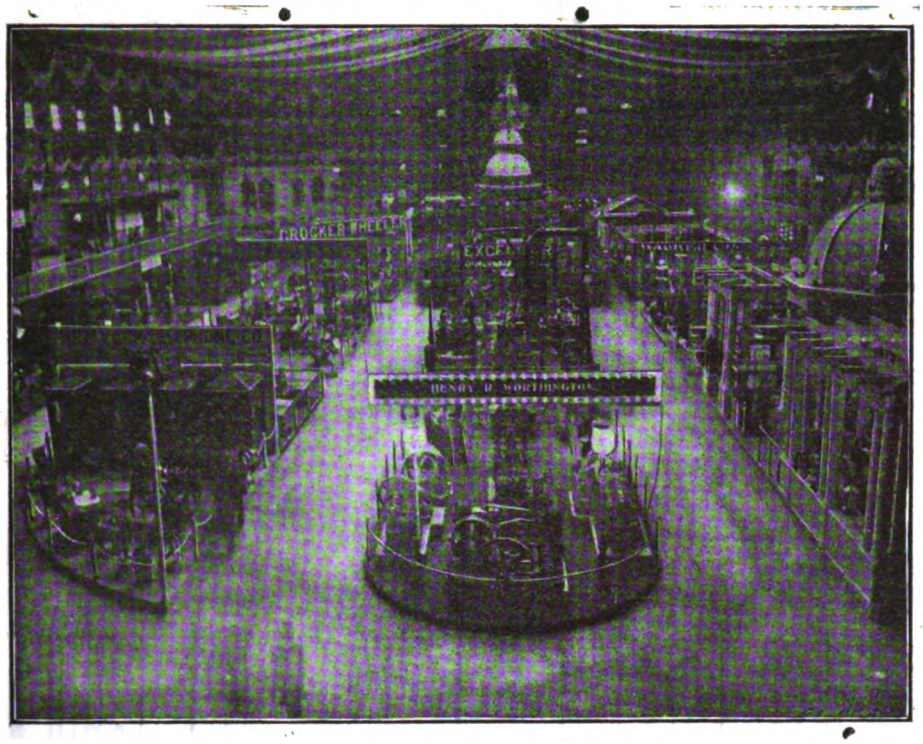
The Electrical Age.

VOL. XXI—No. 19 NEW YORK, MAY 7, 1898 WHOLE NO. 573



[View from Madison Avenue End of Garden.

View from Fourth Avenue End of Garden.

THE FIRST NIGHT OF THE ELECTRICAL EXHIBITION.

New Yorkers are cultivating a love for scientific expositions which certainly shows a high standard of culture and an investigative spirit that could hardly be duplicated in any civilized centre on the face of the globe. The evening of the opening of the electrical exhibition presented a brilliant scene to those attending the function on that occasion. Chauncey M. Depew, New York's beloved orator, made the opening speech and spoke highly of the marvellous aptitude exhibited by Americans in the fields of scientific application. About eight thousand people listened to Dr. Depew's remarks with growing enthusiasm, which rose to a pitch of great intensity when the following letter was read from President McKinley, direct from the White House: It gives me great pleasure to open the electrical exhibition in Greater New York and to participate in this wonderful demonstration of the latest method of recording and publishing by means of electricity. I congratulate you upon the achievements of American genius. I am glad to know that the resources of the wonderful electrical art have already been so far advanced in the United States that American electrical goods are welcomed the world over. —William McKinley." Another letter, from Garrett A. Hobart, the vice-president, was recorded phonographi-

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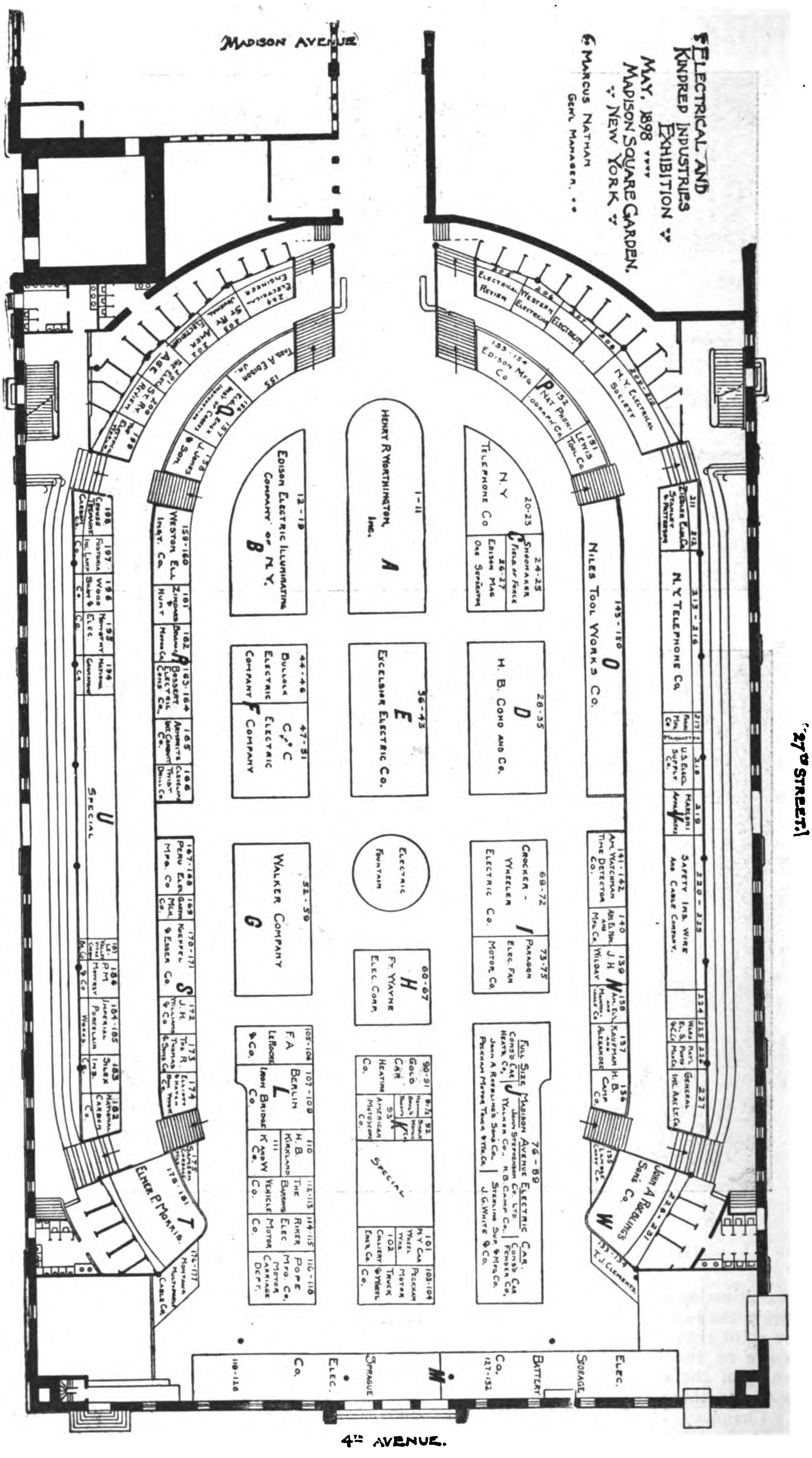
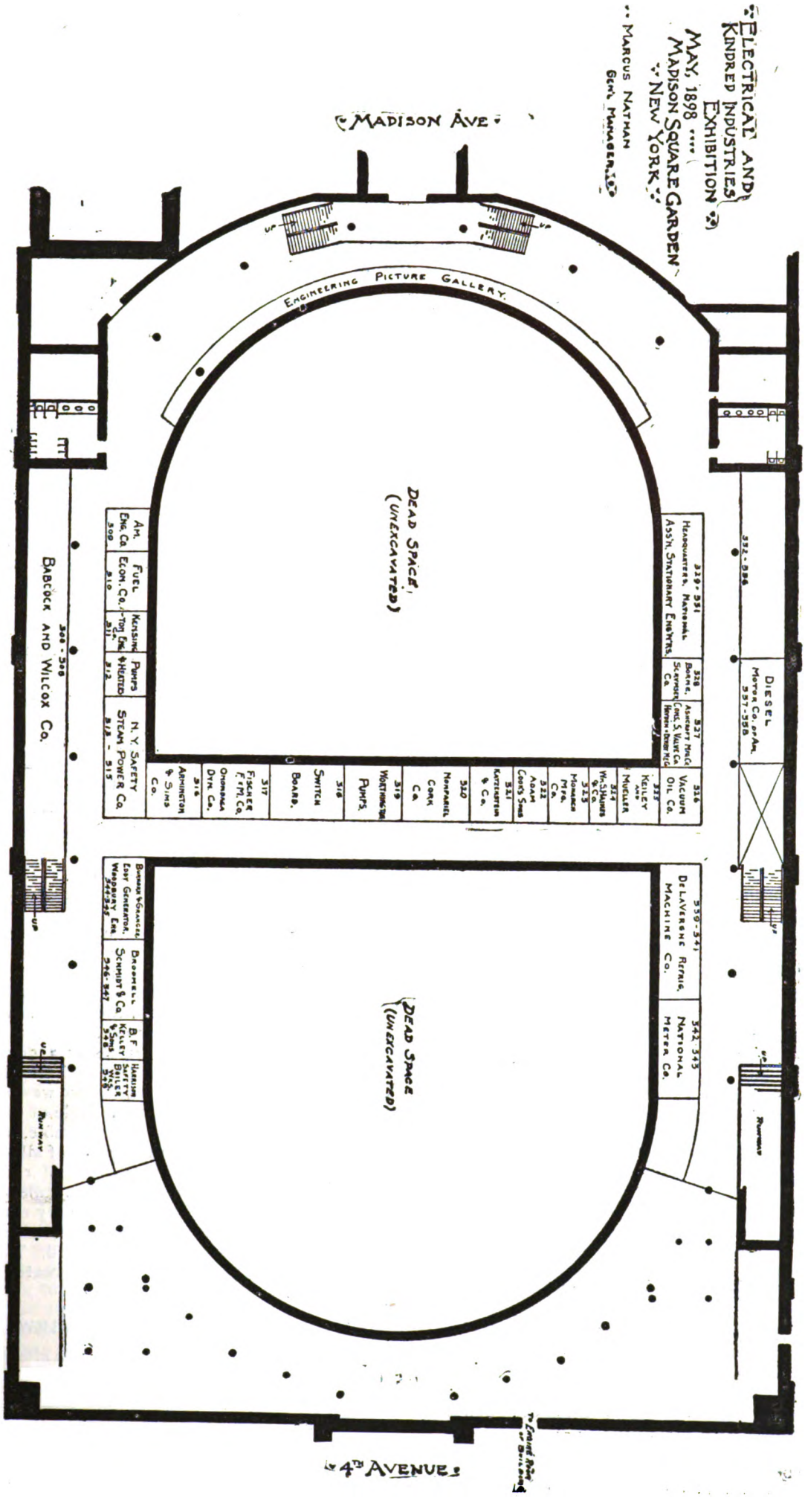


PLAN OF AMPHITHEATRE AND ARENA CIRCLES

26th STREET.



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cally from the telephone receiver and contained the following sentiments: "I respond with pleasure to the invitation of the New York Electrical Society to assist in opening the electrical exhibition held under its auspices at Madison Square Garden, and beg to express my wishes for its success as a means of promoting further advances in the great electrical and engineering arts with which our national fame is already so proudly associated. I congratulate the citizens of Greater New York that they have this opportunity of studying all that is latest and best in the science to which Franklin, even in the midst of patriotic duties and cares, gave his transcendent genius. —Garrett A. Hobart." When these messages were received they were almost instantly set up in an electric type setting machine, printed in an electrically-driven press and distributed at once to the visitors. Dr. Depew astonished his audience by the facility with which a small submarine mine situated in a fountain seventy five feet away was blown up by Hertzian waves, one of the first and greatest applications of wireless telegraphy in naval warfare. The splash occasioned by this unexpected explosion caused some disquiet to those in close proximity to the fountain at that time. Loud cheers rang out from thousands of throats when specail news was received direct from President McKinley in relation to the war. Those that wandered through the bye-ways and labyrinths of this wonderful exhibition saw many remarkable exhibits whose influence in the future upon the advancemcnt of the human race will be most pronounced. Magnificent lighting effects could be seen on all sides, and away upstairs in the southwest corner the strange, weird light of Moore's vacuum tubes lit up a small chapel. The popularity the exhibition has thus far met with is so great that every night the great garden is crowded with curious onlookers, of which a large percentage belong to the fairer sex. Many prominent men have already visited the electrical show and pronounce it on a par with the best they have ever seen.

ALTERNATING CURRENTS AND ALTERNATORS.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

In the many applications of power to various industries none have so occupied the attention and interest of engineers as the use of alternating currents. Years ago the alternator was accepted as a simple device for the generation of reversing currents. Its comparative cheapness of construction and ease of operation have always placed it foremost as the basis of a power plant stretching over rough and rugged countries where attention and skill are of the lowest order. Jablochkoff invented his historic candles for alternating currents and thereby drew attention to its usefulness for arc lighting. In its varied applications we meet with many unique effects. It is striking to notice the results obtained by applying it for the production of light and power and the remarkable developments that have issued from the many attempts to produce a constant and steady light, a self-starting and independent source of power. These problems have gradually reduced the field of alternating-current work to certain constricted lines.

The labors of the past do not partake of the brilliant successes of the present. Continuous and alternating currents stand side by side as indispensable power factors, to be individually applied according to the circumstances, each with its own peculiar set of apparatus designed and perfected to perform its special work.

It is then necessary to accept the achievements of the past as but the beginning of a vast engineering revolution, the final outcome of which will be a new and infinitely more economical means of illumination and a cheaper source of power.

An alternating current is one in which the flow of electricity is constantly reversing. It rises to a high value like an ocean wave and recedes, growing again in the opposite direction in a similar manner. The growth of the current and its reversal in this peculiar manner is due to the arrangement of the lines of force when cut by a revolving conductor. In the alternator a series of poles are arranged around a common centre pointing inwards. As a conductor passes in front of them, each pole creates within the wire a wave of electromotive force. When the wire passes in front of the north pole the rise and fall of current is the reverse of what it would be in front of a south pole. These poles are always some multiple of two —either four, six or eight poles, etc. Therefore we have as many north as south poles. The conductor develops while rotating a continued succession of rapidly reversing waves of electricity, which have earned the name of alternating currents.

Frequency.—The rapidity with which these waves reverse back and forth is called their frequency. If a wire passes in front of a south pole the current rises and falls, but does not reverse in direction. If continued past a north pole the reversal does occur; it is therefore necessary for the wire to pass before two unlike poles to provide a rise and fall and a reverse rise and fall.

Period.—This constitutes a complete current wave. It is called a period. The number of periods are dependent upon the

Number of pairs of poles.
Speed of the dynamo.

To calculate the number of periods in an alternator we observe the following rule:

Number of periods = one-half of the poles $\times$ revolutions per second.

Take a dynamo having poles = 8
speed = 1,200
Periods = $4 \times 20 = 80$ per second.

Phase.—The rush of electromotive force through a wire is such that the entire electrical influence does not pervade it until an instant afterwards. The current does not instantly flow; a certain inertia, as it were, prevents it. The retarding influence may be either the resistance or the self-induction of the circuit.

While it is true that an electric current requires both pressure and amperes to properly deserve the name, it is possible to imagine, upon the closing of a circuit, the electromotive force at work almost at once, as though it were merely a static effect and the current requiring an exceedingly short interval afterward to follow it. In other words, pressure or potential arrives at a given point and affects it before current. The interval elapsing is called the difference of phase. There are two ways of regarding it—as an interval of time or as an angle of difference.

To our minds' eye the first is preferable, as it supplies a physical something within the grasp of all.

Impedance.—The retarding effects of resistance and self-induction give rise to a condition called impedance. The circuit acts as if affected by a heavy resistance; the current is restrained from flowing, and without any great consumption of energy the flow is checked. The frequency also gives rise to this condition to a greater extent than self-induction.

QUESTIONS FOR REVIEW.

(1) What is the differeuce between an alternating and a continuous current?
(2) What is a wave of E. M. F.?
(3) Define frequency.
(4) Define period.
(5) Define phase and impedance.
(6) Are alternators generally self-exciting?

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AN INTERESTING EXPERIMENT IN HIGH-VOLTAGE LONG-DISTANCE TRANSMISSION.

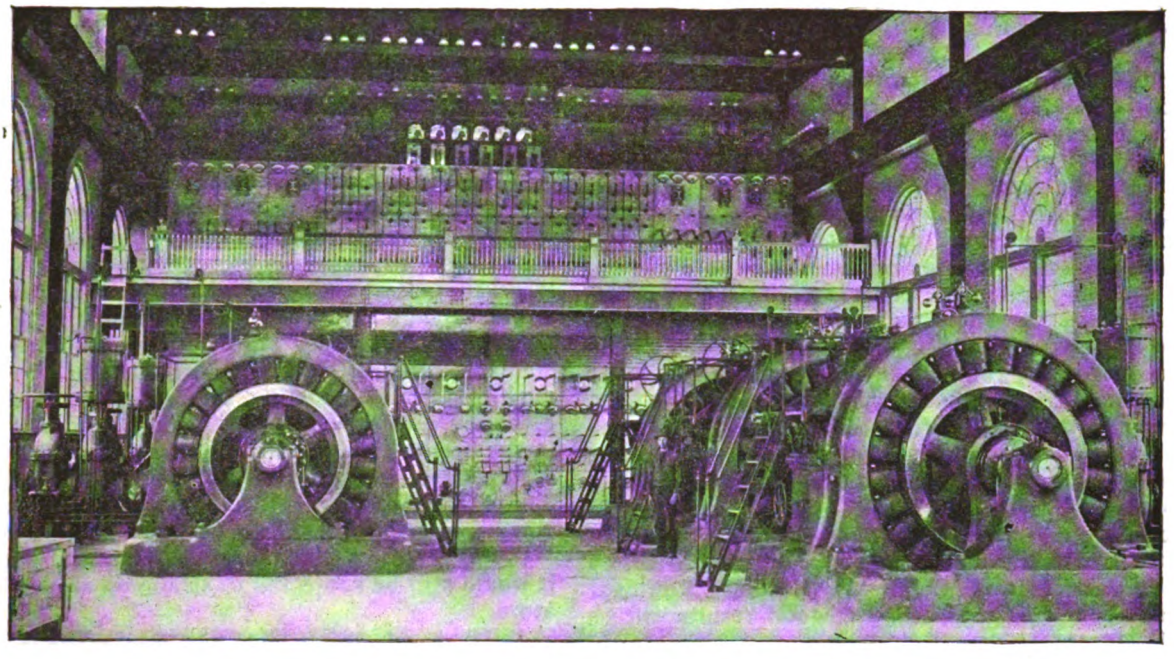
An interesting experiment in high-voltage, long-distance electric-power transmission, pregnant with influence on all transmission work was recently made at Ogden, Utah, in order to ascertain the limits within which high-voltage currents might be used commercially. The experiment was made by Mr. F. O. Blackwell, of the General Electric Company, over the lines which connected the great power-station of what was, until recently, the Pioneer Electric Company at Ogden with the distributing circuits at Salt Lake City, and consisted in connecting the Salt Lake ends of the transmission lines together and dividing the transformers at Ogden, normally used for raising the pressure of the current for transmission, into step-up for the outgoing current and step-down for the incoming. The distance from the power-station at Ogden to Salt Lake City is about 36½ miles. Making a complete circuit of the outgoing and incoming line, therefore, with Salt Lake City midway, gave a complete transmission circuit of 73 miles over three No. 1 wires. The amount of power transmitted amounted to one thousand horse-power, and the voltage at which the transmission was effected reached at times as high as 30,000 volts. The current on the return was delivered to resistance vats at the power-house, consisting of three wooden tanks.

By careful and repeated measurement with watt meters at both ends Mr. Blackwell ascertained that this power was transmitted with the loss of only nine per cent., including four per cent. loss in the two sets of transformers. The drop in pressure due to inductance was practically nil, the capacity of the line being sufficient to compensate for reactance loss.

Continuing the experiment, part of the Salt Lake City Station load was run from Ogden, with current at 24,000 volts. This was supplied to about five hundred horse-power in synchronous motors and lights for two days, under most severe climatic conditions—rain, fog and snow alternating. In addition a severe thunder-storm prevailed all through the night, the lightning-arresters discharging repeatedly. Notwithstanding the severity of the conditions under which the test was made, the motors operated without failure and the lights burned without flickering even during the times of lightning discharges. Not the slightest difficulty of any kind developed while this experiment lasted.

By the recent accomplishment of a scheme of consolidation all the electrical plants in Salt Lake City, as well as the transmission plants, supplying current from it to the outside, have been merged into the Union Light & Power Co. The companies thus consolidated were the Pioneer Electric Power Co., the Salt Lake and Ogden Gas and Electric Company, the Big Cottonwood Power Company, the Little Cottonwood Power Company, the Citizens' Electric Light Company, and certain smaller interests.

The plant of the Pioneer Electric Power Co. is one of the most important installations in the West, and the transmission one of the longest. The power-house is located a short distance from the mouth of the Ogden Canon. The power is derived from the Ogden River, the water being brought to the power-house through a wooden stave pipe and riveted steel pipe line, about 32,000 feet long.



Latest View of Interior of Generating Station of Pioneer Power Plant.

The electric plant consists of five General Electric three-phase alternators—24-pole machines running at 300 revolutions and delivering 750 K.-W. each at 2,300 volts and 60 cycles. The compiete plant is designed for ten units or a total output of 10,000 H. P. The exciters are G. E. six-pole 500-volt Kilowatt dynamos, each of ample capacity to excite ten generators. Each alternator is directly connected to a Knight water-wheel of 1,200 H. P. capacity, and each exciter to one of 135 H. P.

The current is fed into the transmission lines from the step-up transformers at 16,100 volts, and delivered to the step-down transformers at 13,800 volts. They are ordinarily connected in delta, but can also be connected in Y to raise the potential to 25,000 volts whenever it is desired to run at the higher potential in order to increase the capacity of the line or the distance over which the power is to be carried. The switchboard panels on the gallery at the end of the power-house are for the outgoing feeders, and are arranged to handle potentials of 25,000 and 30,000 volts. Everything necessary to control the operation of the electric and hydraulic machinery has been carried to the switchboard panels on the same level as the generators.

Both step-up and step-down transformers are of the air-cooled type and are each of 250 K.-W. capacity. The pressure of the current for local distribution to the smaller transformers at Salt Lake City is 23,000 volts.

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INSULATION AND CONDUCTION.

BY REGINALD A. FESSENDEN.

HIGH RESISTANCE INSULATION.

(Continued from page 243.)

In laboratory apparatus in many cases, for instance with electrometers and resistance boxes, we need as high ohmic resistance as it is possible to get. Here, however, we are met by the fact that the two substances most commonly used, i. e., hard rubber and glass, are among the poorest insulators known for this class of work.

Rubber is very objectionable from the fact that whilst it presents a nice bright appearance when new, it contains sulphur and is very easily oxydized, especially when exposed to light. A film of sulphuric acid is thus formed on the surface, and if the tongue be applied to a piece of rubber which has been in use for some time the taste of the acid is very strong. I have seen the top of a Wheatstone bridge, supposed to be capable of measuring accurately to one part in 5,000, in which the total length exposed to leakage, divided by the average distance between which leakage could take place and the average voltage was only .008, with the top so acid that the tongue could hardly be allowed to touch it.

As a rule, it is very hard to remedy this; rubbing the surface does no good, as the acid extends in to some distance. Rubbing with cigar ashes is advocated by some, but I should fancy it would be almost impossible to remove the last traces of alkali. The method used by the writer is to steep the rubber in warm 10 per cent. caustic soda, then in warm distilled water, frequently renewed, then drying in the dark quickly and rubbing with pure paraffin, treated as described under paraffin, then polished while warm. This does good for a time, until the paraffin takes up dust.

For rods, a good way is to treat as above and coat half an inch thick with paraffin; then run over the rod with a wooden die and cut a thread in the paraffin. Run over the thread about once a month, and good results will be obtained.

With bridges, however, it is impossible to remove the top, and the only thing which can be done is to keep them covered up from light.

Rubber has also one other disadvantage, in that it does not show dirt, and where rubber comes in contact with copper it is apt to rot.

Glass is very bad because the alkali in it has a great affinity for moisture. The alkali is slightly soluble, and hence it is the custom with analytical chemists to boil all beakers used in exact work for several days before using, so as to get the soluble alkali and silica out of them. When possible, this should be done with the glass of electrical apparatus.

Another very serious trouble is that the angle of contact between water and glass is zero, so that when a drop of water is placed in the middle of a pane of clean glass it immediately spreads all over it in a thin film. This method is used by chemists to determine when a glass is clean. Nothing much can be done with glass but to keep it dry. Sulphuric acid is generally used, but it sometimes, if allowed to get dust in it, gives off vapors which condense on the side of the apparatus. This, however, does not often happen.

Evidently we need some substance of high ohmic resistance and one which water will not wet. Boys, who has earned the thanks of electricians for his happy discovery of an almost perfectly elastic fibre, has given us also, as he himself has pointed out, such an insulator in quartz. Dip a thread of glass in water and lay it between the knob of a charged electrometer and the ground, and the leaves close almost at once, the whole fibre being covered with a film of water. Treat a quartz fibre similarly and the water slides off it, or remains in little drops each separate from its fellow, and the insulator is apparently as good as the air itself.

Quartz should therefore be used as much as possible in electrical instrument work. It can be melted in a powerful gas flame furnace, and though it can never be melted down free from small bubbles, these make no difference except in appearance. It is, however, possible to obtain glass which contains no alkali, and resembles quartz in that it is not wet by water. Such a substance is Faraday's borate of lead glass, as he himself points out. This is, however, too brittle for most work, but by an admixture with silica a glass could no doubt be made which would be perfectly satisfactory. If some glass manufacturers would take up this question and furnish us such a material for electrical instruments, the greater part of the present annoyance met with in making delicate experiments would vanish. It would not leak, would show dirt, could be readily cleaned, and would be free from one of the great disadvantages of rubber, i. e., a large coefficient of expansion, which is always making trouble by bending terminals of resistance coils, thus changing their value and sometimes opening the circuit.

It is also probable that a fine grade of porcelain would be a great benefit to the electrical profession, if coated with a good non-alkaline glaze.

For insulating the coils of resistances it is doubtful if we have any good solid material. For paraffin cannot be used, as its expansion and contraction are so great that large pressures are put upon the wire, and the resultant strains change the resistance. It might be easy enough to prevent the strain on the first solidification in a way similar to that devised by Rowland for cementing flat mirrors without buckling them, i. e., by mixing a little glycerine with the beeswax; the glycerine not dissolving in the beeswax makes it act like a viscous fluid, i. e., deform under the action of infinitesimal forces in time. The glycerine, however, finally works its way out like zinc in a resistance alloy (as first pointed out by Mr. Weston), and if a similar method were used with the coils it would still be subjected to strains on change of temperature.

Another objection which has been made in England is that paraffin absorbs moisture. It is possible that this is due to the dissimilar methods of producing American and English paraffin, as I have never had to complain of this, except, of course, when cold paraffin was placed in saturated moist air. The insulation resistance of paraffin seems, however, to be markedly increased by the treatment mentioned below. The great objection to paraffin is its tendency to collect dust. Shellac has been recommended, and since the coils are in the dark the material will oxydize but slowly, and if care be taken to use pure alcohol for a solvent, and not denaturized spirit (which sometimes contains conducting impurities), has a very high resistance when dry. Some forms of Japan lac seem to remain flexible permanently, as, for instance, the sample A (composition unknown), which is ten years old.

Oil is sometimes used for resistance coils, and this is without doubt the best method, since the great point in the use of resistance coils is to know their temperature. The writer's experience with manganin and constantin as practical laboratory standards has been unfortunate, and he has hence decided to use only standards of pure lead run into glass tubes and kept in water. The reason is that, other things being equal, the most sensitive Wheatstone bridge is that which takes the greatest current without appreciable heating, and in the ordinary form of resistance coil a very small current will heat the interior up to such a temperature as to alter the value. Moreover, if the coil is of a material not affected by such changes of temperature, it (with our present alloys) will have a larger temperature coefficient, and as the temperature of the interior of the coil is not known this introduces another uncertainty. With the oil mounting, how-

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Our issue of this week was delayed on account of the removal of the Printer.

TESTING OF STEEL ARMOR PLATE BY INDUCTION.

It is unnecessary to state in how many cases the principle of induction has been used, but it is certainly of importance and immediate consequence to point out how a new application may be made of it. The great fighting battle-ships of this country depend for their efficiency upon the thick belt of armor surrounding them and reaching three feet below the water-line. It is a great satisfaction to know that this armor is free from blow-holes, homogeneous, and capable of withstanding the tremendous shocks of projectiles hurled at it with the force of thousands of foot-tons per second.

A suggestion contained within this article is simply to the effect that steel armor could be tested by an induction method, which would certainly lead to the conclusion as to its availability for naval purposes.

In an article published by Prof. D. E. Hughes in the proceedings of the Physical Society of London, volume third, page one, called "The Induction Balance and Experimental Researches Therewith," a method is outlined which, if applied to metals of any given thickness, will afford a means of scientific comparison which is by nature so accurate as to rise above criticism, test or inspection of any other description. The Hughes induction balance has been utilized on a small scale for the purpose of testing counterfeit coin, but it will find its immediate use in detecting pieces of defective armor-plate in the same manner. Blow-holes in the metal and differences in the proportions of metals used in any samples tested will be immediately detected.

The simplicity of the method and the ready means of discrimination offered should lead to its immediate adoption by the naval department of the United States in examining each piece of armor-plate before it is placed into position upon the vessel's hull.

In the present war, success will depend as much upon the effectiveness of the armor employed as upon the penetrating power of the projectiles, and it would seem as if a vessel properly armored, having smaller-sized guns than its opponents, would do greater damage than if its guns were larger and its armor weaker. If the United States desires to realize its hankering wish to become the greatest naval power in the world, it will have to pay special attention to the qualities of its armor, the strength of a battle-ship lying more in this than anything else that can be considered.

The testing of armor plate by means of a gigantic induction balance would put a quietus on all doubts as to the invincibility of the armor manufactured, within the limits of the specifications, and would add to the confidence of those entrusted with the care of one of our floating forts.

TRANSMISSION OF POWER AT HIGH POTENTIALS.

The increase in transmission lines has become very marked in the last five years. The greatest and most successful of them send alternating, two or three-phase currents over the power line. The rapid growth of polyphase transmission plants may be readily traced to the invention and commercial application of polyphase motors. The labors of Tesla, Dobrowolsky, Steinmetz and Bradley have been particularly fruitful in this respect; and to them a large percentage of the enterprise leading to the installation of great transmission plants is directly attributable.

The erection of lines carrying high potentials has opened up a broad and comprehensive field of investigation to the contracting engineer. In transmitting alternating currents, the efficiency of transmission is dependent upon the resistance of the line, the frequency and the pressure; and it is well understood by those engaged in this work that the saving in copper is not at all desirable if carried out at so great a sacrifice that the economy is thereby affected. The facility with which a high potential alternating current may be sent, received and transformed again to a commercial pressure has led to the adoption of that system in all cases where power of any consequence is to be delivered.

Marcel Deprez was among the first to attempt to obtain any practical figures relating to the efficiency, cost, etc., of transmitting electrical energy. His conclusions were well received and made a subject of study by others interested in the same field of work. Lord Kelvin framed his important law at about this time and showed the capitalist that the cost of power wasted should not exceed the interest on the invested capital spent in the construction of the power line. Many conclusions were arrived at of a valuable nature relating to power transmission that have been faithfully followed out at home and abroad by different engineers.

It is highly evident to those interested in this subject that the cost of line construction is a direct function of the pressure at which the energy is transmitted, and in reviewing the history of transmission plants it will be seen that a strong tendency exists leading to the use of higher and higher potential in transmitting any considerable quantity of power a great distance. The limit reached seems to be that greatly dependent upon the resisting power of the insulators on the lines and insulation in the transformers, and it follows as a matter of course that the perfection of either of these will result in a higher efficiency of transmission due to the use of several thousands of volts more in the line.

A study of transmission plants therefore resolves itself

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down to a study of insulation and its limits, which are best expressed in terms of frequency and resistance. It is a common thing to hear of pressures being sent over the line of ten thousand volts, but the time is near at hand when twenty and thirty thousand volts will not be considered extraordinary, as all future developments of this kind depend entirely upon improvements in insulation, which, in the light of Prof. Fessenden's remarks upon "Insulation and Conduction" before the American Institute of Electrical Engineers, is not a problem of the greatest difficulty. It seems as though insulation specialists were as necessary in this profession as nose, ear, throat and lung specialists are in the practice of medicine.

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ever, this is all done away with, and pure oil has a very high resistance for low voltages.

For condensers and induction coils it is not only necessary to have materials of great ohmic resistance and of great dielectric strength; they must also be perfectly pure and free from admixture. For the first two properties there is nothing so good as paraffin, when properly used, all compositions such as beeswax (cerotic acid), etc., being quite inferior in both respects. Paraffin, and what is practically the same thing, pure ozokerite, will stand, according to the tests of Mr. Chesney, which I had the pleasure of witnessing, at the rate of 500,000 volts per inch. This I have confirmed up to 60,000 volts, alternating. Most substances, such, for instance, as glass, are at once cut out from consideration from the fact that they have too much electrical absorption, and heat when subjected to a fluctuating voltage.

(To be continued.)

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The 124th meeting of the Institute was held at 12 West 31st street on Wednesday evening, April 27th, Mr. H. Ward Leonard in the chair. About sixty members and guests were present. A paper on "An Economy Test of Central Stations" was presented by Prof. W. E. Goldsborough, of Lafayette, Ind.; also a paper on "A Novel Form of Thermo-Electric Battery" by C. J. Reed, of Philadelphia, which was accompanied by experiments. The discussion was participated in by Messrs. Cox, E. P. Thompson, Mailloux, Reed, Wintringham, Steinmetz, and W. M. Mordey, of London.

At a meeting of the Executive Committee in the afternoon the following Associate Members were elected:

Wyatt H. Allen, care H. F. Allen, 202 California street, San Francisco, Cal.

Wm. H. Fitzhugh, Supt. Bay City Electric Plant, Bay City, Mich.

John Breckenridge Fleming, Mill Superintendent and Cons. Engineer, Austin Mining Co., Austin, Nev.

George J. Henry, Jr., Engineer for N. Y. Branch, The Pelton Water Wheel Co., 143 Liberty street, N. Y.

N. S. Hopkins, ass't engineer, General Electric Co., Box 825, Schenectady, N. Y.

Robert Lindsay, general supt., The Cleveland Elec. Ill. Co., 717 Cuyahoga Building, Cleveland, Ohio.

Frederick A. Muschenheim, electrical engineer, Western Electric Co., 57 Bethune street; residence, 41 West 31st street, N. Y. City.

Newton L. Schloss, consulting engineer, 39 Cortlandt street; residence, Stuart House, N. Y. Citv.

Clarence M. Tolman, electrical engineer, with Edw. G. Stoiber, Silverton, Colo.

Ernest Stiles Vinten draughtsman, Walker Co., New Haven, Conn.; residence, 89 Pearl street, New Haven, Conn.

MADISON SQUARE GARDEN.

ELECTRICAL SHOW opened May 2nd in a radiance of light, with blare of trumpets and the eloquence of our only Chauncey M. Depew; the telegraph; blowing up of a submarine mine by Clarke's Hertzian waves or electricity without wires at a distance of several hundred feet; Thomas A. Edison, Jr.'s, beautiful fountain, and many other interesting features that go to make this the greatest show ever held in Madison Square Garden. The night scene on the tower is grand and attracts crowds from the surrounding country.

Among the elaborate and beautiful exhibits we start on a pilgrimage at the left of the Madison Square entrance and are received by SMILES and a grasp of the hand by GLADSTONE, who are receiving guests and detailing the features contained in the exhibit of the EDISON MANUFACTURING COMPANY. They show a beautiful line of X-Ray outfits, kinetoscopes, medical apparatus of all kinds, Edison-Lalande batteries with and without fan motors; also phonographs, and the greatest of all, Edison Symphony Concert Records.

WE NEXT VISIT THE NILES TOOL WORKS, the great Cincinnati industry, with offices at 123 Liberty street, New York. Everybody is acquainted with machinery, but not everybody is acquainted with Niles tools. If you are a manufacturer you cannot afford to pass by this exhibit.

THE ADJACENT BOOTH contains watchmen's clocks, supervised by Mr. Morse, the agent, of 253 Broadway, New York.

HELLO! is the exclamation when you strike the next booth. Why, he is engraving by electricity. Yes; it is MR. J. H. WILDEY, engraving on all kinds of metal by his patented electric engraving machine, which he sells at his offices 23 Duane street, New York.

IF YOU HAVE A SWEET TOOTH you can have it satisfied by buying candy at the next stand, and you can also quench your thirst and that of your lady companion at the adjoining booth. As you are tilting your glass, enjoying your soda, without a "stick," your eyes strike the illuminated sign "CHLORIDE ACCUMULATORS" under the balcony of the Fourth avenue and 27th street end. Here is the fine exhibition of storage batteries, showing their application to boats, motors and all kinds of electrical apparatus, all under the supervision of MR. BLIZARD, their New York manager, who has offices at 20 Broad street, New York.

HEAR THE SWEET STRAINS OF WAGNER'S LOHENGRIN. Why, that comes from the organ in the SPRAGUE ELECTRIC COMPANY'S big exhibit. MR. VANDEWATER, the assistant manager of the company, is at the organ playing popular airs. He is so popular himself that he can't help it.

Where does all this wind come from? Why, that comes from their famous "Lundell" fan motors, found in every nook and corner of their big exhibit. It's a wonder that they were able to make a good showing of their "Lundell" power motors, as writer knows they had to refuse orders within this present week. They are

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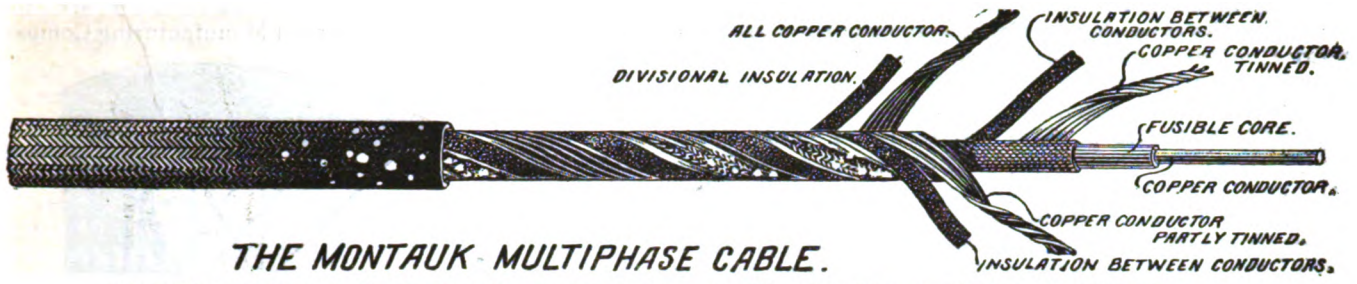
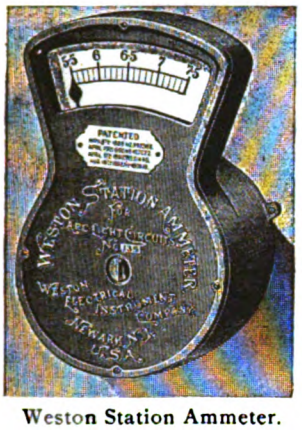
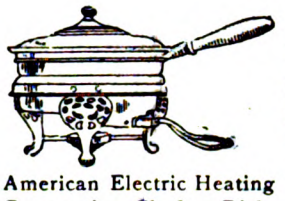


THE MONTAUK MULTIPHASE CABLE.

SHOWING FUSING EFFECT AFTER CONTACT WITH DANGEROUS HEAT OR FLAME.

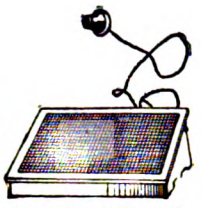


Weston Station Ammeter.

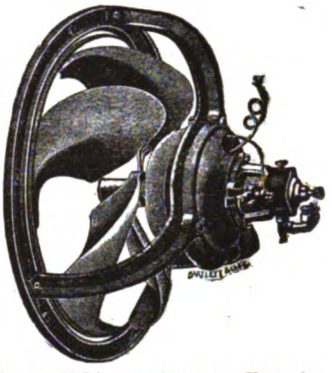


American Electric Heating Corporation Chafing Dish.

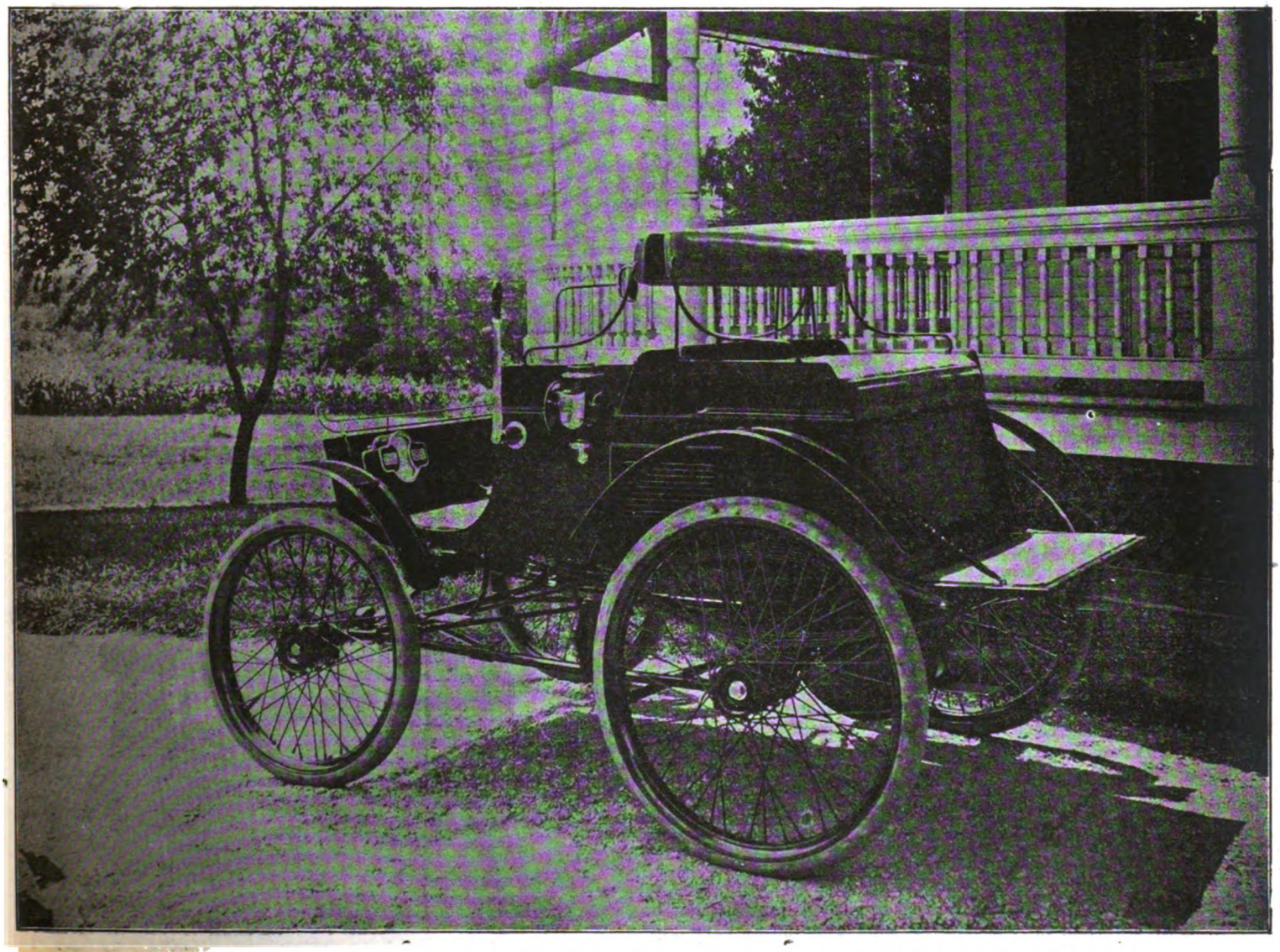
A Well Known Trade Mark.



American Electric Heating Corporation Foot Warmer.



Lundell Blower, Sprague Elec. Co.



The Riker Carriage.

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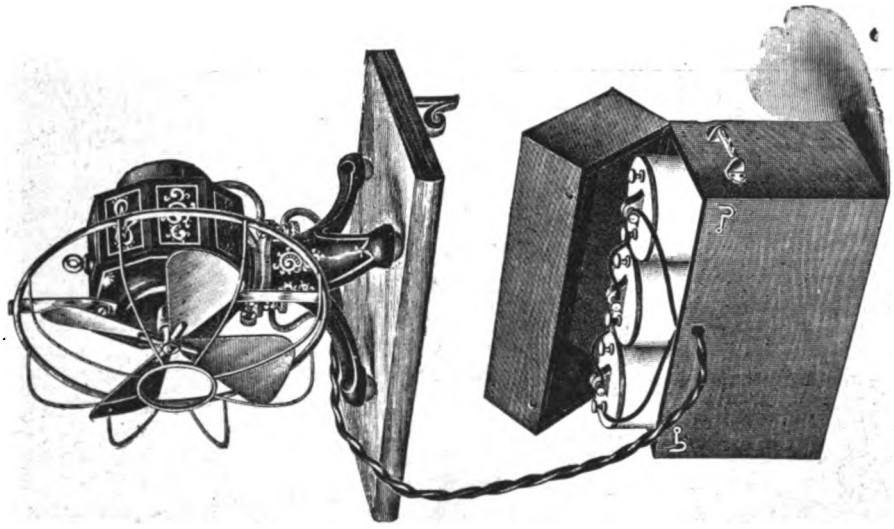
working night and day to catch up with the demand. The great Sprague electric elevator and their noted "Interior Conduit" that so many have tried to imitate is attracting the admiration of thousands. It would take all our space to try to describe this exhibit.

GOOD MORNING, MR. GOULD. I hope MR. PRICE is well. These two are the genial president and secretary, respectively, supervising and practically illustrating the great advantages of the Montauk Multiphase Wires and Cables, address 100 Broadway. With one of these wires or cables running through your house, store or factory, in connection with a bell, or telephone, or telegraph, or messenger call, or window or door openers, or electric light or anything else electrical, you always have an instantaneous fire alarm, as the wire or cable is constantly thermostatic. If a fire should break out in the vicinity of this wire or cable, it gives an instant alarm, and you may have it connected with the auxiliary fire alarm system, for the call of the fire department. This is one of the greatest inventions of the age, and everybody should call at the beautiful booth of the Montauk Company and have them give you an exhibition of the operation of their thermostatic wires and cables.

After that the booth contains SAMPSON'S CORDAGE for all electrical and street railway applications.

THE NEXT booth contains samples of drop forgings of J. H. WILLIAMS & COMPANY, of Brooklyn, N. Y.

KEUFFEL & ESSER COMPANY come next, the greatest manufacturers in the world of drawing materials



Edison Mfg. Co.'s Battery Fan Motor Outfit.

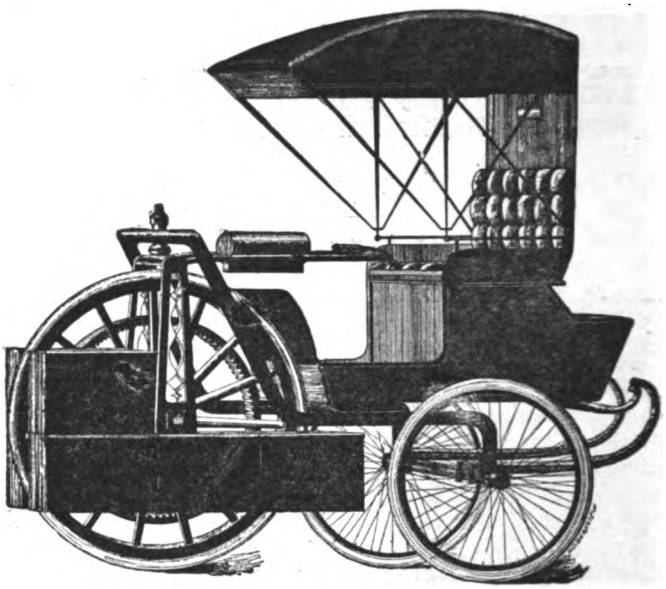
and instruments of precision. They display a very large and assorted line of electricians' drawing instruments, surveyors' outfits for electric railway men, Helios paper for blue printing drawings, etc., and a variety of goods that every electrician should use.

GARVIN MACHINE COMPANY, of Spring and Varick streets, New York, exhibit a large line of machine tools for manufacturing fine electrical apparatus. They are one of the busiest companies in the country today and no doubt make the finest line of tools and exhibit the greatest variety, either at the Electrical Show or at their great works, Spring and Varick streets. What you cannot find here no one else can supply you with.

PERU ELECTRICAL MANUFACTURING COMPANY, of Peru, Ill., exhibit in the next booth a big line of porcelain goods, as well as their large line of carbon goods for batteries, etc. They make a very handsome showing and are proud of it. A very elegant show case is next door, containing a full line of Cleveland twist drills.

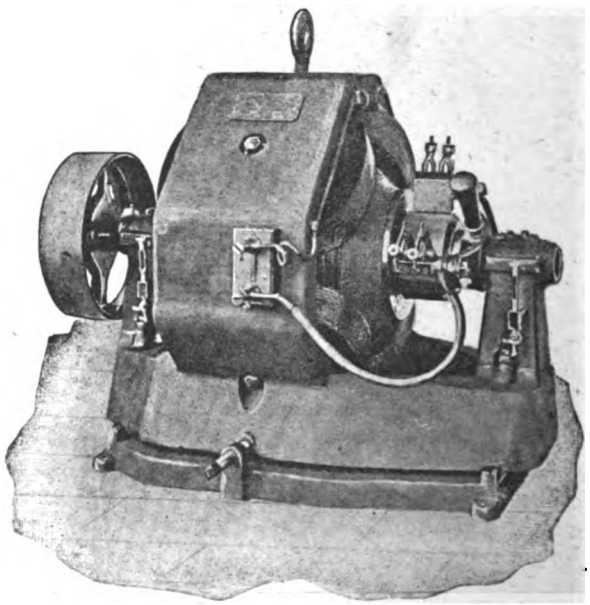
THE NEXT EXHIBIT contains the giant of the show, the only ROBERT COREY and his Armorite Conduit. This is the wood-lined iron tube conduit that has been so much talked of lately and is becoming very popular among the contractors,

W. T. BOSSERT is in the next exhibit, prepared to do battle for the Bossert Electrical Manufacturing Company,



Barrowes Electric Carriage.

Chloride Accumulator.



Eddy Generator Run as a Motor in Coho & Co.'s Exhibit.

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of Utica, N. Y., manufacturers of steel boxes or receptacles for conduit systems. To fully appreciate Mr. Bossert's exhibit, if you are a contractor, you must call and see his exhibit and get his explanation, especially of his new line.

WE NEXT VISIT ZIMDARS & HUNT, one of the main attractions of the Electrical Show. To enter this fine exhibit you open the circuit of an immense single-pole switch, ten feet long, the knife of which forms the gateway. Mr. John T. Hunt, of the company, assisted by Mr. Atkinson, the superintendent of the works, explains to your satisfaction all the details of the great variety of switchboards, panel boards, switches, automatic motor starters, etc., contained in the elaborate exhibit.

THE WESTON ELECTRICAL INSTRUMENT COMPANY occupies the next space, which is about twenty feet wide, one of the largest in the Show, with rich show cases containing a large variety of samples of their standard volt and ammeters, alternating current and watt meters, multivolt meters and everything used for power and station work; switch-board instruments of all kinds.

WHEN WE COME opposite the beautiful exhibit of the Edison Electrical Illuminating Company, Mr. J. Jones, Jr., of J. Jones & Son, will give you a hearty welcome to one of the most elaborate booths of the Show. It was shocking to see how some young men took hold of his medical batteries last night. That switchboard in the back part of J. Jones & Son's exhibit is the talk of the Show. The name of J. Jones & Son in ground glass lamps on a rich plush back ground cannot be surpassed for beauty of design and finish. Their switches, panel boards, etc., exhibited by Mr. Jones are all manufactured in their large works in Brooklyn Borough, Greater New York. They have moved into their new building, 64 Cortland Street. First floor is the salesrooms, second floor of offices, basement for shipping and upper floors for stock. For every $5 purchase you get a free ticket to the electric show.

THOMAS A. EDISON, JR.'S, exhibit comes next. Mr. Edison himself has the sympathy of all his acquaintances. By his over-zealous ambition last Tuesday night to get the great fountain in the centre of the Show in operation, in some manner he had three of his fingers on his right hand broken, a most serious and unpleasant accident at the beginning of the Exhibition. It has not marred his anxiety to make the Show a success, as can be seen in his beautiful exhibit to the right of the Madison avenue entrance. Mr. Gill, a very popular representative of Mr. Edison, Jr., is kept constantly busy explaining the virtues of Edison, Jr., lamps and more particularly the fickle people desiring Mr. Edison's personal signature.

HOW CAN WE DESCRIBE the beautiful exhibition made by the Edison Electric Illuminating Company? Those great white columns and domed cupola all brilliantly illuminated with Edison lamps. The EDISON DECORATIVE AND MINIATURE LAMP DEPARTMENT, of Harrison, N. J., must be given great credit for the beautiful manner in which they carried out the installation of the illuminating effects of this booth.

In the Madison avenue end are all kinds of electrical cooking apparatus furnished by the AMERICAN ELECTRIC HEATING CORPORATION, of Boston, Mass. In another part is shown an ice machine run by an electric motor, also a printing press, ceiling fans in operation, arc lamps, and every application of electricity.

RIGHT OPPOSITE the Madison avenue entrance is the large exhibit of the H. R. WORTHINGTON COMPANY, of New York, where are shown compressed engines run by large electric motors, and condensers of all kinds for electric light and railway power plants, and everything for the engine room.

NEXT TO THIS is the NEW YORK TELEPHONE COMPANY's booth containing long-distance telephones and telephone booths for secret telephoning. This company has an adjunct to their exhibit in one of the galleries to the left of the Madison avenue entrance, where they are receiving nightly over the telephone the music and performances of the different theatres. Wednesday night we had the pleasure of hearing from the Broadway theatre, the singing, music, speaking, and even the applause of the audience.

THE PARAGON fan motor exhibit on the main floor attracts great attention with a great pyramid of motors. One of the features of this exhibit is Mr. Williams's baby rocked in a cradle operated by one of his new Paragon power motors. The swish of air created by the pyramid of fan motors is very refreshing. It is a perfect western cyclone and will be more highly appreciated in the coming warm days of the Show. With his usual generosity, Mr. Williams has offered to keep all exhibitors cool by furnishing their booths with a fan motor free of charge.

THE FORT WAYNE ELECTRIC CORPORATION show their immense arc and incandescent generators, as well as their general line of alternating and direct-current apparatus. Their Duncan watt-meters are in great demand.

F. A. LAROCHE, of the Ideal Electric Corporation, made a big showing of their new automatic circuit breakers in operation. They are set up and connected with volt and ammeters and rheostat, so that you can see the exact reading at the time they break the circuit. They also show their various styles of dynamos, switches, etc.

THE RIKER ELECTRIC MOTOR COMPANY, of Brooklyn, attract a constant crowd of people examining the beautiful motor delivery wagon built for Altman & Company, the big dry-goods people in New York City. They also show their electric motor Victorias, all operated by Chloride Accumulators. They have a number of their Riker fan motors in operation, and Mr. Riker himself creates a halo around the booth.

THE BARROWES VEHICLE COMPANY, 302-306 West 53rd street, New York, exhibit their motor vehicles at the Show. They show the most novel line of electric motor vehicles. They operate in conjunction with the Willard storage battery, which is all suspended on a powerful pneumatic-tired single wheel in the front of the vehicle, operated like a bicycle handle from the seat of the vehicle. By having all the weight on the single wheel in front, they claim it gives greater traction and takes away all vibration in the carriage.

THE POPE MANUFACTURING COMPANY exhibit their Columbia motor carriages, operated by Chloride Accumulators. All the mechanical work on these carriages and delivery wagons are in the usual style of the Columbia wheels, finished in a very ornamental and substantial manner.

WE NOW LOOK UP into the gallery from the Pope Manufacturing Company's exhibit and spell out the name E. P. Morris. There is only one E. P. Morris in this Borough, and he is making a big show at the Garden, and his goods as well as himself must be seen to be appreciated. He has a little room partitioned off from his exhibit wherein he receives his dearest friends. I have not been made acquainted with the full contents of this room, but you can feel assured, readers, that there are some fine cigars there. These cigars are not as strong as the great Monarch paint he handles, that will insulate everything electrical, from a wire to a dynamo. He handles the noted Keystone volt and ammeters, everything needed in the electric railway line and everything in the supply line, from a push button to a dynamo.

WE COME along the gallery and find the only Prof. Ker in the Show, representing that popular educational institution, the Hebrew Technical Institute. He is showing a beautiful line of models, from a complete dynamo to an ordinary spark coil, all made by the boys in the Institute, and put on exhibition for the purpose of drawing some of the prizes.

FROM THE NEXT booth we hear the musical notes

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of the GRAM-A-PHONE echoing throughout the Garden.

WE HAVE already passed the Le Vallee Vitae Carbon Company. They show a full line of carbon cylinders for open circuit batteries, as well as a full line for all battery uses.

THE NOWOTNY ARC LAMP is in this gallery in an elaborate booth, and they are letting their light shine as an example for buyers to call and leave their orders.

WOOD, SHAW & COMPANY come next with a full line of the noted Partridge carbon brushes for dynamos and motors, Universal lightning arresters; and Mr. Harry Shaw himself, who lately hitched horses with Mr. Wood, have their offices at 42 Broad street.

THE CROUSE-TREMAINE CARBON COMPANY is in the next booth, manufacturers of every kind of carbon.

THE NEXT BOOTH is one well to be remembered. The Fostoria Incandescent Lamp Company have their booth fitted out in front with brilliantly illuminated Greek columns surmounted with globes all brilliantly illuminated with Fostoria lamps. The columns contain spirals of pretty colored low-volt lamps. In the back of the booth is a large board containing all styles of 220-volt lamps, a new feature of the incandescent lamp business.

WE COME NEXT. The Electrical Age booth was the first one completed at the show, and we take pride in writing it, as we distributed the first electrical paper at the Electrical Show, Monday afternoon and evening, containing accounts of the exhibition.

THE SAFETY INSULATED WIRE & CABLE COMPANY has without doubt the finest exhibition at the Show—Fort Safety they call it. You look into the mouth of one of the great disappearing guns and there the word appearing within its interior is "Safety." Then we look overhead and find the Stars and Stripes thrown to the breeze. By the ingenious idea of the Safety Company the flag-pole is made hollow, and through an opening in the pole they throw the breeze from a fan motor upon the flag. They show in the centre of the booth an exact model of Sandy Hook with a beautiful battle-ship at anchor with the channel filled with submarine mines. Every visitor receives a disappearing gun with the word "Safety" printed on the same. Messrs. Requa, Eckert, Richards, Williams, Holloway, are the representatives of the company at their beautiful booth.

STANLEY & PATTERSON, of 32 Frankfort street, New York, one of the largest supply dealers of this city, have a large booth in the gallery filled with all the most novel electrical goods, from a push-button to a complete X-ray outfit, and to complete the exhibit Messrs. Stanley & Patterson are there every evening to receive their friends. WE FOLLOW THE CROWD up the stairs over the Madison avenue entrance and enter Music Hall, filled with lay figures of all the ancient electrical dignitaries. IN THE FAR LEFT-HAND CORNER is a stairway leading up to Moore's chapel. The constant stream of people kept the writer from visiting this beautiful exhibition of vacuum-tube lighting, but the following remarks were overheard from visitors to the chapel:

We cannot conclude these remarks about the Electrical Show without reference to our friend and faithful worker, Mr. Marcus Nathan, the general manager. Everybody had a good word for him. They all praised him, from the employé to the biggest exhibitors. Similar tributes were paid to his assistants, Mr. T. Martin, Mr. Osterberg; Mr. Deronda Levy, Mr. M. Norden, Mr. Lardner and the faithful work of the trustees of the Exhibition, C. O. Baker, G. F. Porter, L. F. Requa, etc.

The Berlin Iron Bridge Co., of East Berlin, Connecticut, manufacturers of iron trusses for electric light, power, etc., and roof supports. They are light and airy and are specially insulated. You are invited to inspect the handsome structure they have in the electric show.

The Bullock Electric Mfg. Co. have lately issued a small card in which they enclose all their letters to machine builders and factory owners.

On one side of the card is diplayed a cut of one of their motors operating a 72-in. planer. The motor is of small size and is placed on top of the planer, allowing a travelling crane to pass over it. The shaft of the motor is coupled direct to the main driving shaft of the planer. The motor is shunt wound to give constant speed under varying loads, and has a capacity of 12 horse power.

On the other side of the card is a short description of the arrangement of motors on machine tools and the advantages to be derived from this mode of supplying power. The card is printed in two colors and makes a neat enclosure for letters.

American Electrical Novelty Co., 231 Broadway, N. Y. exhibit at the electrical show a fine line of automatic and push button lighters for all kinds of home uses; some are very ornamental. You must see this line of fine electrical goods when you visit the show.

H. W. Kirkland, 120 Liberty Street, N. Y., is special agent for the Cutter Electrical Manufacturing Co., makers of the popular automatic circuit breakers for central stations and electric railways and small power circuits. They can be seen in operation at the electric show.

Otis Brothers & Company, of the Potter Building, New York, are exhibiting an improved push button device used in connection with their well known electric elevators. A small working model of the same is on view in the exhibit of H. B. Coho & Company. The device is used for operating electric elevators in private residences and other places where no operator is employed in the car. The movements of the car are controlled by buttons, inside and outside the car, the device not operating unless the doors leading to the shaft are closed. This insures absolute safety, not only to the occupants of the car but also to outsiders.

H. B. COHO & CO., 30 Cortlandt St., N. Y., manufacturers of switchboards, panel boards, expert electrical engineers and contractors for electric light and power machinery, especially the general repairing of dynamos and motors. This branch of the business was taken up by them after a number of years' experience in having this work done outside. They are selling agents for Eddy apparatus and The Warren Electric M'f'g Co. They are making big exhibition at the electric show. They exhibit a direct-connected Eddy dynamo, 15 H.P., to a Van upright gas engine, switchboards, panel boards, and American rheostats, crown brushes, Watertown engine and new-type, 6-pole Eddy dynamo, No. 3 Eddy plater, 75-K. W. Warren alternator, and two new-type Eddy iron-clad motors.

WESTON STANDARD ILLUMINATED DU STATION INSTRUMENTS.

THESE INSTRUMENTS are based upon the same general principle and are just as accurate as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger, and the working parts are inclosed in a neatly designed dust-proof cast-iron case, which effectively shields the instruments from disturbing influences of external magnetic fields.

WESTON ELECTRICAL INSTRUMENT CO.

114-120 William St., Newark, N. J., U. S. A.

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In use by Fire Alarm, Police Signal, Telephone, Telegraph, Railroad and Marine Service.

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Gas Lighting by Electricity.

Static Electric Machines and Burners for the Multiple System.

CHARLES H. HINDS,
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TRIO BUILDING.

General Electric Co.'s
NEW X-RAY TUBE

With Automatic Vacuum Regulator.

No more Troubles from High Vacuum Tubes.

SIMPLE AND EFFICIENT.

Keeps Vacuum Adjusted Automatically. Can not run too high in Vacuum for Operation. Life practically unlimited.

Roentgen-Ray Exciting Apparatus: Thomson Inductoriums, Thomson Roentgen-Ray Transformer Sets, Fluoroscopes, etc. Catalogue No. 9050.

Miniature Lamps: Candelabra, Decorative, Battery and Series. Catalogue No. 9044.

Edison Decorative and Miniature Lamp Department,
(General Electric Co.)
HARRISON, NEW JERSEY.

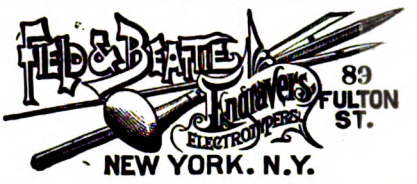
WATER WHEELS

TURBINE WHEELS, for Heads of 3 to 220 feet.
CASCADE WHEELS, for Heads of 50 to 2000 feet.
Suited to all Water Power Purposes.
Pamphlet of either Wheel sent free. State your Head.

JAMES LEFFEL & CO. Springfield, Ohio, U.S.A.

TELEPHONE No. 2957 CORTLANDT.

Wood Cuts, Photo-Engravings, Half-Tones,



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EDISON'S
NEW STANDARD PHONOGRAPH.

EVERY FAMILY SHOULD POSSESS ONE.

Records Reproduces, shaves off cylinders, has sapphire points. Runs 3 records with one winding of spring. Weight, 17 lbs. Complete, as per illustration,

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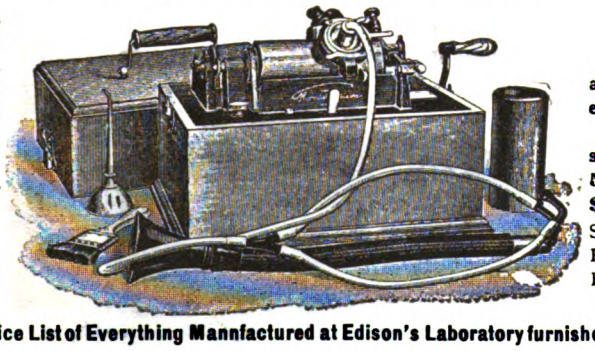

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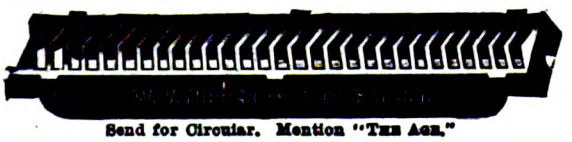

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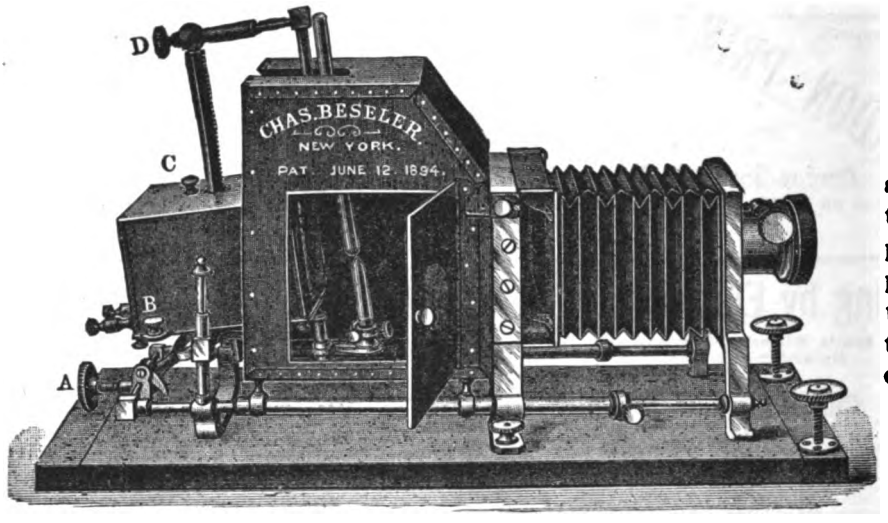

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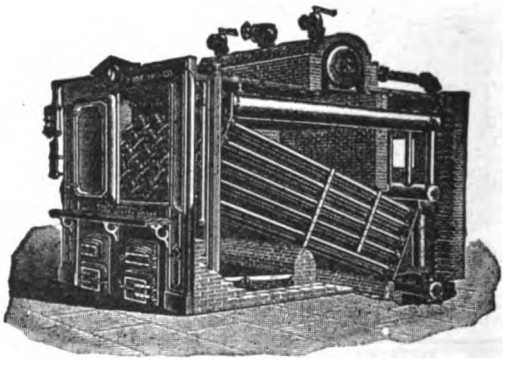

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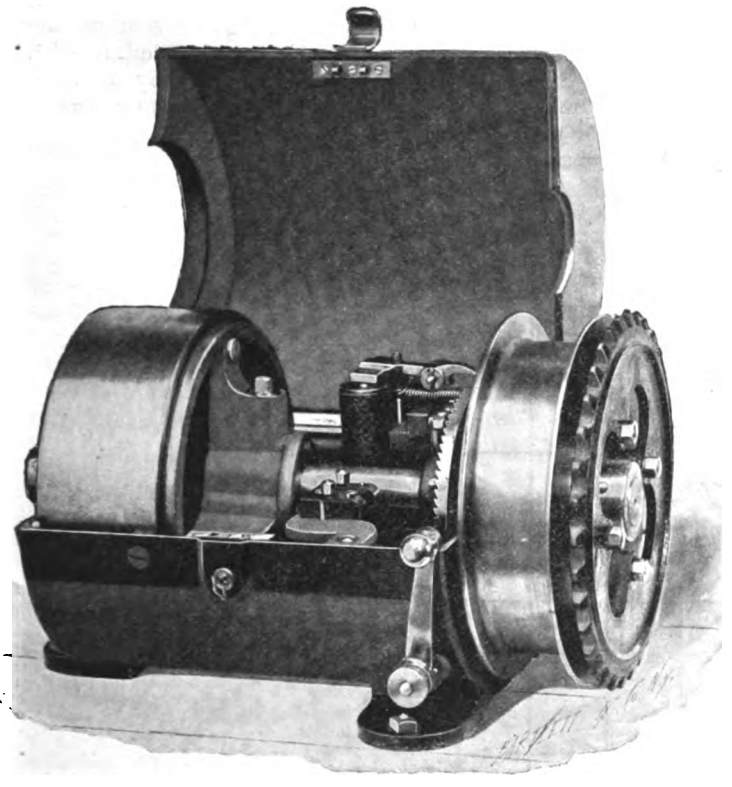
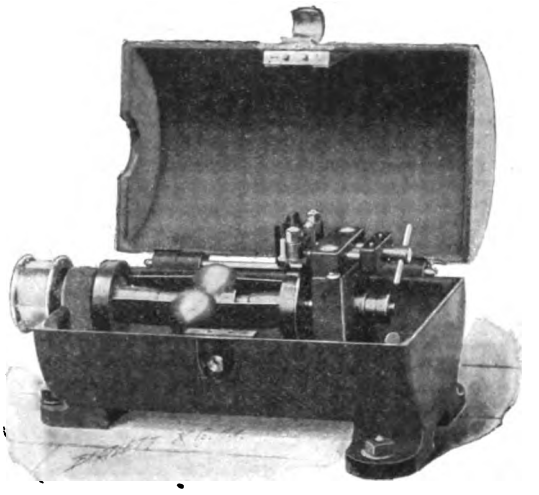
The Electrical Age.

VOL. XXI—No. 20 NEW YORK, MAY 14, 1898 WHOLE No. 574



Monarch Engine Stop.



Automatic Speed Limit.

THE MONARCH ENGINE STOP AND AUTOMATIC SPEED LIMIT.

The Monarch engine stop is one of the latest products of the engineering world, and represents a combination of an electrical and mechanical nature which prevents an engine from exceeding its normal speed. This ingenious affair does not require any attention after installation, as it operates with absolute certainty and cuts off the steam supply at first very rapidly; then with diminishing speed. In case the engine should by any accident begin to race, the engine stop will throw into action an electro-magnet which, by the motion of its armature releases a detent and allows a drum to revolve rapidly, thereby shutting off the steam supply, that is to say, the throttle valve. A sprocket wheel attached to the drum is spun around by means of a suspended weight, a cord connected to which is wound around the drum. When the drum is allowed to rotate by the descent of the weight, which is caused by a release or pawl, a sprocket chain connecting to a sprocket wheel on the throttle valve turns with it and closes it.

It is possible to set this engine stop so that it will operate at any given speed, immediately shutting off steam when the limit is reached. The speed limit represents a combination consisting of a governor which operates a contact collar which, according to the speed of the engine, will move the contact collar backward or forward, closing the circuit by pressing upon two slips of metal, threby sending current through a magnet which, by the mechanism previously described, shuts off the engine.

When the engine speeds up beyond the proper number of revolutions per minute, the governor balls are thrown out, the contact collar slid forward, current circulated through the electro-magnet and the steam throttled. It is possible by the aid of this device to stop the greatest Corliss engine in existence through the medium of an ordinary push button. The illustrations show the engine stop with ratchet catch, electro-magnet, drum and sprocket wheel. In the illustration of the speed limit is shown the governor, movable collar and contact slips. The value of these innovations are being shown to the utmost advantage at the Electrical Show in Madison Square Garden. They are being manufactured by the Monarch Manufacturing Company, 39 Courtlandt Street, New York.

ELECTRIC HEATING, LIGHTING AND VENTILATING AT THE MACKAY MAUSOLEUM AT GREENWOOD CEMETERY.

The inside of the Mackay Mausoleum is lighted by sixty 10-C. P. incandescent lights placed at the base of the dome roof and are hidden from view by a heavy marble cornice; the sixty lamps are set in a horizontal position and underneath the lamps there is a special white enameled copper reflector fitted to the base of the dome in such manner that the light is reflected to the dome which is decorated with Venetian mosaic work; by this means the whole of the interior of the mausoleum is thoroughly lighted without any shadows, there being a perfect diffusion of light, and a very pleasing effect.

The heating and ventilating of the mausoleum is accomplished by a series of plates being charged by a current of 220 volts, taking altogther 80 amperes of current, installed in four series of 20 amperes each, so that any desired temperature can be obtained according to the requirements of the owner. There is in connection with this electric heater a nine-inch air duct carried to the outside of vault so as to obtain a current of fresh air, which, in passing over the heated plates, gives a current of pure warm air to the interior of the mausoleum, which in turn passes out at the top of dome, thereby completing the system of perfect ventilation for the interior.

The heating apparatus is sunk in the centre of the

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mosaic floor and covered by a handsome bronze grill work perfectly flush with the floor.

The lighting and heating is controlled at the panel and distributing board set flush in one of the black Belgium marble panels inside the mausoleum, which is enclosed in a handsome bronze frame and marble door.

The whole of the above work was designed and installed by Zimdars & Hunt, 127 Fifth avenue, New York city.

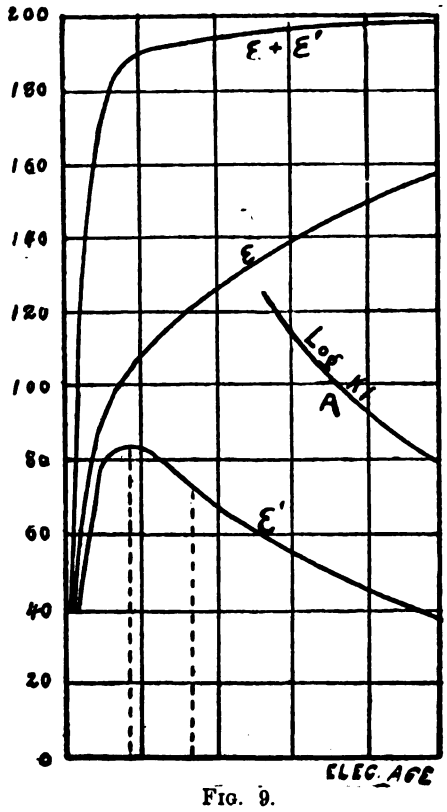


FIG. 9.

INSULATION AND CONDUCTION.

BY REGINALD A. FESSENDEN.

(Continued from page 260.)

We must have an electrically homogeneous dielectric, i. e., one of the same specific inductive capacity all through. This is for two reasons. First, because, if we have a dielectric A between two charged conductors, the introduction of a dielectric of greater specific inductive capacity even if of infinite dielectric strength and ohmic resistance, will cause A to break down. To take a numerical case,—suppose we have two plates, 1 cm. apart, and attached to the terminals of a 10,000 volt A. C. dynamo. (Fig. 5.) Suppose the dielectric, air, to support 50 per cent. more than this pressure. Introduce two plates of glass of K = 8, each ¼ cm. in thickness. Since the voltage divides itself up inversely to the capacitance, we will now have 8,889 volts between C and D. This being at a rate of 17,778 volts per cm., and as it only supports 15,000, we will get a spark between C and D at every reversal of the voltage, which will quickly heat the glass and make it conduct. The full potential of 10,000 will then be between C and D, and a regular arc will form.

Thus we see that the introduction of a good insulator will, in all cases where an intermittent or alternating voltage is used, have the paradoxical effect of weakening the insulation, unless the whole space is filled up with the material. This weakening is not generally apparent at once, as the spark takes some time to eat its way back, and this explains why many induction coils only last for a few years of operation.

Another cause is that treated of by Poisson, Clausius and Maxwell.* This is, that layers of dielectrics of different capacities and resistances show electrical absorption, and this theory has been proven experimentally by Muraoka, who showed that by taking two fluids, neither of which showed absorption, a layer of one on top of the other did do so. Maxwell treated the general case. It has, however, been treated in a more specialized way by in "La Lumiere Elec.," 1891. In this paper are brought out the following points:

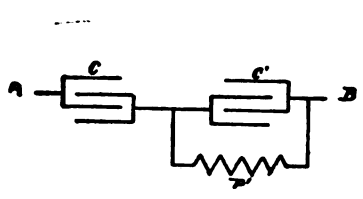
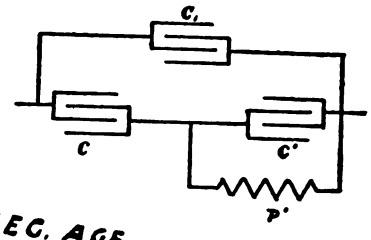


FIG. 7.



ELEC. AGE

FIG.

1. A dielectric, as in Fig. 6, containing conducting particles of water, for instance, may be considered as an arrangement of condensers and resistances in series and shunt with each other. Two cases, shown in Figs. 7 and 8, are worked out, and Fig. 9 gives the curve of charge in the cases of Fig. 7; E is the voltage on the condenser part and E^1 that on the condenser and resistance.

2. A condenser can show large residual charge, though its true ohmic resistance is infinite.

3. With dielectrics showing absorption, there will be found some discharge time at which the amount of dis-

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charge will be constant at all temperatures.

4. Why in some tests insulation seems to be lower with higher voltages.

5. Why the presence of conducting particles increases apparent capacity.

6. That to get true ohmic resistance of most dielectrics, voltage must be kept on for a long time, even for days.

7. Why Siemens' method of taking the rate of loss of charge by electrometer does not give correct results.

8. That specific inductive capacity of such dielectrics can only be determined by rapidly alternating currents. This possibly explains an effect noticed by the writer many years ago, i. e., that an A. C. static wattmeter immersed in water did not give anything like the torque it should have if the true value of K for water were 80.

9. The importance of getting out the last traces of water in gutta percha and paper when used for cables.

As mentioned, this author considered a simple case of Maxwell's general theory and proved the above results by making actual measurements on condensers and resistances connected up so as to correspond to a simple case of a dielectric of high resistance with conducting particles in it. This paper should be read by all electricians, especially those concerned with cable work. I would like to speak of this subject more in detail, but for lack of time will only add that most of the conclusions in that paper have been confirmed by me, and that some which had been arrived at independently were seen to be in perfect agreement.

It is this absorption and the consequent losses which make glass useless as an insulator against high A. C. voltages. In some experiments made by Messrs. Stanley and Chesney, which were shown to me, the glass plates of the condenser when on an A. C. voltage (though thick enough to have stood ten times the D. C. voltage) after a few moments got hot, sparks could be seen passing inside the glass, and the plates finally broke down. Glass is not homogeneous, as it is made up of a number of substances, some much better conductors than others, and of different capacities and all stirred together, but not dissolved. This is shown by the care which has to be used in getting glass homogeneous enough for optical purposes, it even having, as has been told me by Mr. Brashear, to be kept perfectly horizontal when annealing, as the heavier parts tend so much to sink down to the bottom, even when the glass is only plastic, that the only way to do is to keep the levels of different density parallel to the surface of the disk so that their effect on the light will be as equal as possible for all rays. Otherwise one side of the lens would be of heavy glass and the other light, while at present it is so arranged that one face is dense and the other light.

Mica is much less objectionable, especially if its cracks are filled up and it is well dried. Paraffin when properly treated makes very good condensers. The old method of piling together pieces of paraffin paper and tin-foil and then pressing them, left much air and moisture inside. This produced large electrical absorption and gave large capacity. Messrs. Hutin and La Blanche were the first to discover that good condensers could be made by heating such condensers till the moisture and air were expelled. Their results† showed that the specific inductive capacity of this more homogeneous dielectric could be reduced from 8 to 2.5. I have myself found it come down as low as 2. They then found that the same results could be obtained by heating the paper before making up the condenser. Since then this method of forming condensers by heating them to expel moisture, air and acid has been used quite generally, with some modifications and improvements resulting in a shortening of the process.

It may be said as a general rule that the capacity of all substances showing absorption may be reduced by this treatment, if the heating be kept up long enough. A great many oils, for instance, are given high capacities, but I have found that in many cases this can be greatly reduced by this method, and that the slight remaining excess of K over that called for by Maxwell's theory can be almost entirely removed by removing the free fatty acids, mucins, etc. Oils tested by me were olive, castor, linseed and cottonseed. All these have very high insulation resistance and low specific capacity when so treated and purified, but they soon lose this again when exposed to air.

It is evident, therefore, that the anomalous results obtained by Hopkinson and others were due, in some cases at least, to impure material, and such results must be considered as forming a strong proof of the correctness of Maxwell's theory.‡

But when the substances are not themselves solid, but viscous, they must have a mechanical backing. For this pure cellulose is generally used. Pure cellulose contains some loosely combined moisture. Consequently it can exist in two states. Dried below 100° C. it decreases its specific inductive capacity very much, and has very high resistance and is flexible. Kept above 100° C. for any length of time, it loses some of its combined water, has a much higher ohmic resistance, and its specific inductive capacity sinks to 1.9 or 2. It, however, becomes very brittle, and even though the temperature be only a few degrees above 100 C. it finally cannot be bent without breaking. (This brittleness must be carefully distinguished from the so-called rottonness which cotfon fabrics get when dipped in linseed oil and drled. The fact that cotton tears easily in such a condition is due to the same cause as makes a wire mosquito netting tear when painted, i. e., the fibres are stuck fast by the varnish and cannot help one another. This can be proven by removing the dried oil, when the fibre will be found to have nearly its original strength.) In this condition it is best suited f r making condensers.

The paraffin itself is greatly improved, as was pointed out by Hutin and Lablanc, by heating to about 140 C. Tnree hours' heating I have found satisfactory. The dried paper, immediately on removal from the oven, is plunged into the hot paraffin, so as to protect it from absorbing moisture. The condenser is then made up and boiled, so as to remove the air, for several hours. This boiling method was described in a recent patent as a novelty, but it was used by Mr. Chesney at Pittsfield in 1891.

A condenser so made, if perfectly pure cellulose is used (perfectly pure paper is used in practice), and with pure paraffin, will sta.d 250 volts per thousandth of an inch when the dielectric is less than .01 inch, and at a higher rate for greater thicknesses, when the effect of small defects in one sheet of paper is not so serious.

Practically the same remarks apply to the making of induction coils. Here, however, we meet with the great difficulty that paraffin in cooling is sure to shrink, and will leave hollows inside. The way to get over this is to construct the coil so that when cooling the shrinkage will take place outside, just as if one were making a casting of some metal having great contraction. The coefficient of adhesion also should be less between the walls of the mould and paraffin than between the wire and paraffin; also the outside should never be let harden first, as then, of course, a hollow space is left inside. Another precaution is to expel all gases by heating the paraffin for some time above the temperature at which the coils are to be boiled. The coils should be boiled above 100° C. for some hours to drive off the loosely combined water. This destroys the mechanical strength of the cellulose, but as the whole coil forms a solid mass this is of no great consequence.

(To be continued.)

* "Elec. and Mag.," vol. 1, chapter x.

† La Lumiere Elec.; July 25, 1891.

‡ A rule connecting this effect with the sign of the Kerr's electrostatic optical effect has been given by the writer.—Elec. World, Jan. 2, 1897.

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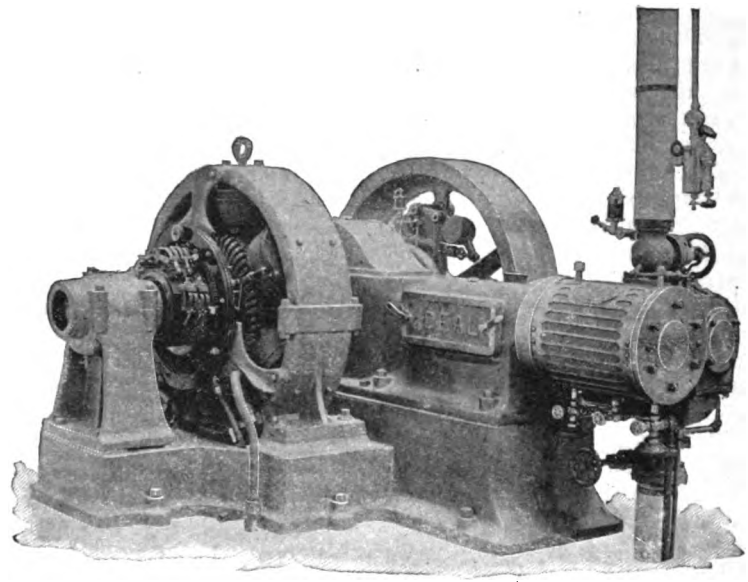
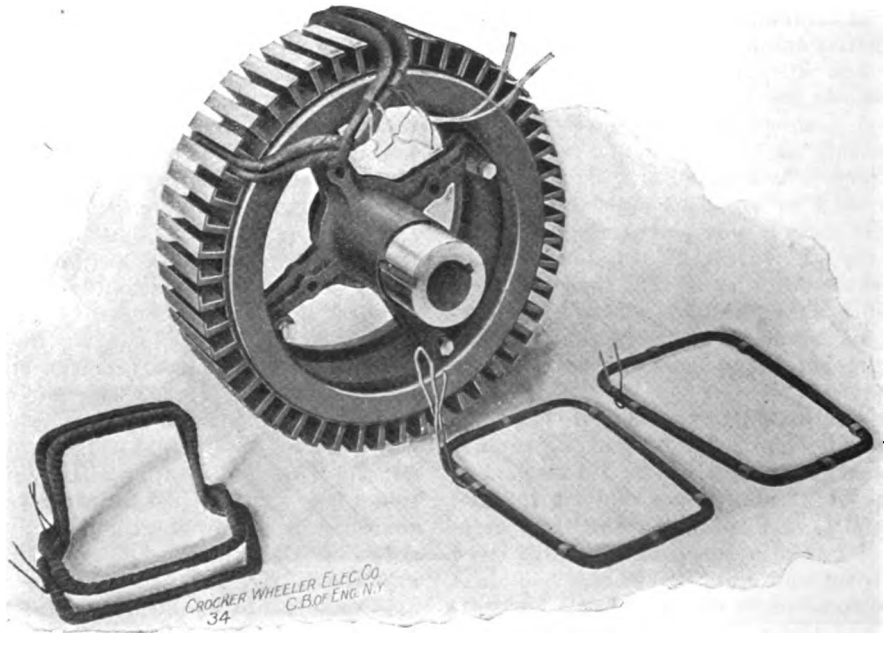
IMPROVEMENTS IN ARMATURE WINDING.

Many of our readers who have followed the subject of dynamo design will undoubtedly appreciate this sketch, showing one of the most improved methods of armature winding in vogue at the present stage of the art. The armature here depicted is of standard size and design and represents an advance beyond the customary forms of toothed armatures. The laminated body is held and clamped within a frame-work looking like a four-spoked wheel. The winding is formed before it is put on, thus saving a vast amount of time and labor. The teeth being made of sufficient cross section to carry the field sent through them do not give rise to any irregularities in its distribution. Humming and heating are entirely absent and the armature when complete is perfectly balanced magnetically and mechanically. The simplicity and consequent value this process gives rise to means sparkless commutation and the absence of dead resistance due to extraordinary lengths of end wires.

The Bradley system with copper bars offers the same advantages, but requires more care and is therefore more costly. The practice of using formed coils has grown to an extraordinary degree, making hand-wound armatures in many respects behind the times. Where speed in manufacturing is aimed at, and compactness with minimum weight, the above method must be followed out in every respect. A model isolated plant direct-connected means not only effective mechanism, with economy in operation, but cleanliness and no noise as well. There are many electric light plants owned by private individuals looking more like a ladies' boudoir than a place where heavy machinery is in operation; the æsthetic taste being now as strongly developed in competent designers of electrical machinery as the idea of having the machinery they manufacture operate to advantage from a dollars-and-cents standpoint.



30 K. W., Size 33 Direct-Connected Dynamo on Ideal Engine. Crocker-Wheeler Electric Company.



Armature Core, Showing Method of Winding and Applying Formed Coils. Crocker-Wheeler Electric Company.

VISITORS AND EXHIBITORS to the Electric Show all wonder where the mechanism is in the enclosed arc lamp lighting J. JONES & SONS' exhibit. There is no magnet or wire used in the lamp except to connect the two terminals. It operates by gravity and the gas formed in the enclosed bulb. Stop and see how simply this arc lamp works without any mechanism. They are just being put on the market.

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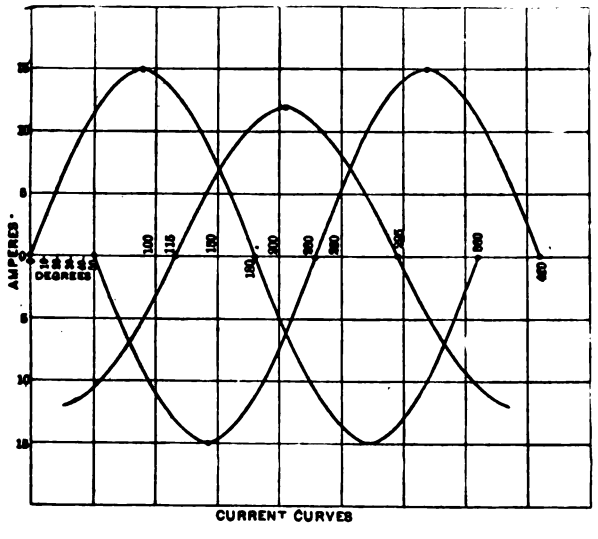
TRANSFORMERS.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

(1.) The interesting methods by which alternating current apparatus is designed and constructed, and the peculiar effects manifesting themselves, have given rise to a closer study of the subject in all its varied details. Not only have some of the greater difficulties been overcome, but its introduction beside and as an active and equal competitor of continuous currents in a commercial and practical sense is plainly evident.

Alternating current motors.—For many years the slug-



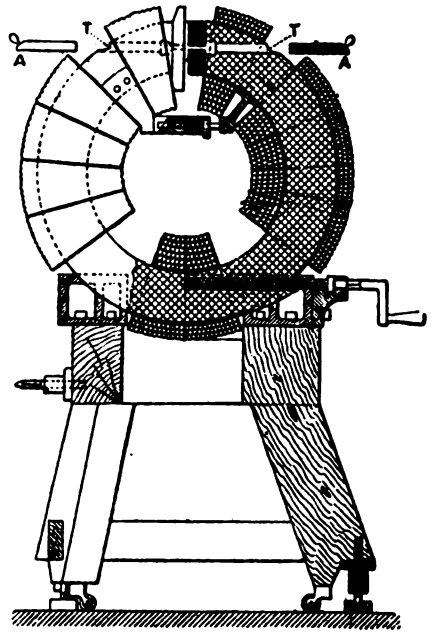
Alternating Current Curves.

gish progress of alternating-current practice could be easily traced to the lack of a motor which could compete in the open market with the others. It had been deemed impossible to construct one of this kind. To obtain power in the form of mechanical energy from an alternating-current circuit necessitated the use of another alternator of the same frequency. This motor, to be, was rotated up to its proper speed by some additional device, and then the current applied.

Synchronism.—With the frequency or periods of both generator and motor equal, the machines are said to be in "step," or in synchronism with each other. The difficulty now arises, however; with a dropping in speed of the motor, this condition of electrical harmony, as it were, ceases to exist. Both machines fall out of synchronism, and the motor, after a short interval, comes to rest. This difficulty was for a long time ineradicable. It was impossible to start an alternating-current motor from a condition of quietude, and likewise impossible to hold it in synchronism with considerable changes of load. Any continuous-current motor, at least, possessed this qualification of being self-starting; a great handicap, therefore, stood in the way of making an even test of both systems. A difficulty of this character deprived the exponents of alternating-current machinery of a most valuable feature. Transmission of power was not very practical, although the mere laying of a long line was and has been an easy achievement.

Rotary Field Motors.—It was discovered by our famous inventor, Nikola Tesla, that if by any possibility a magnetic field was caused to travel around an iron circuit, or in any way allowed to affect an armature core wound or bare—if the metal mass in the centre is free to rotate—this circulating field will drag it around at a high rate of speed. A rotary field is produced by means of polyphasal currents—peculiar impulses, identical with an ordinary alternating current, but consisting of not one, but two or three successive impulses forward and the reverse backward.

Polyphasal Currents differ in no respect from an ordinary alternating current. A single impulse rising and falling in a wire can, in imagination, be succeeded by another before the first has begun to decrease. Likewise, the second might be followed by a third impulse, which has the same difference of phase between it and the second as exists between the second and the first. This system can be developed to any extent. To create a rotary field, for instance, with a current of these impulses or



Device for Producing Intense Magnetic Fields.

waves, a ring of iron wound with three coils each one-third round, and receiving successively a wave of electromotive force, would naturally produce a magnetic field of this description. Whether iron or copper be placed in the centre, the field will drag it around. A polyphasal current means a current of many phases; the word poly meaning many. The additional fact that when an armature is gripped at points all around its periphery it is better able to develop torque, has made this innovation decidedly practical.

A Sine Wave is the name given to a wave of electromotive force of current proceeding from an alternator. It was discovered by Joubert that the mathematical curve called the sine curve and the diagrammatic representation of a rise and fall in electromotive force differed so slightly from each other that the latter deserved the same name.

True Value of the Current.—An alternating current has no fixed or uniform value. It rises and falls like an ocean swell, beginning, growing rapidly to a hilly prominence, and subsiding again to nothing. There is no definite value to be given to the flow of an alternating current that is other than approximate. At each instant of its growth and decrease it has a decided value, but this constantly changes, varying from nothing to a maximum; that is, its highest value. We are forced, therefore, to judge by approximation of its real strength; in fact, to measure it by two methods.

Mean Current.—One of these methods is that of taking the value of the current at successive instants of its rise and fall and forming an average, calling this the mean current. If the current rose and fell and the seven tests

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showed the values of

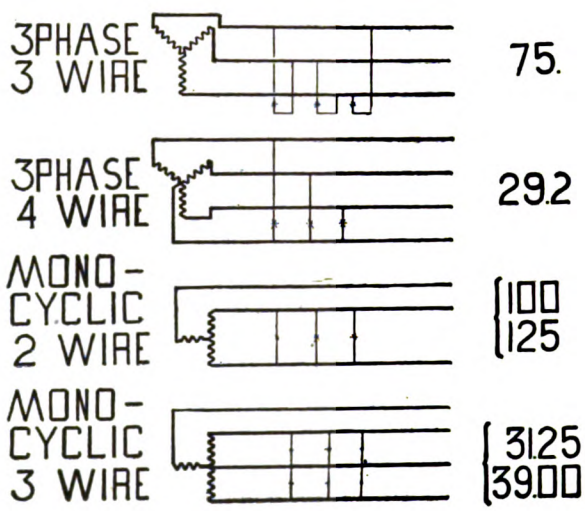
0
2
4
6
4
2
0

the average would be $\frac{18}{7}$ therefore $\frac{18}{7} = 2\frac{4}{7}$ amperes.

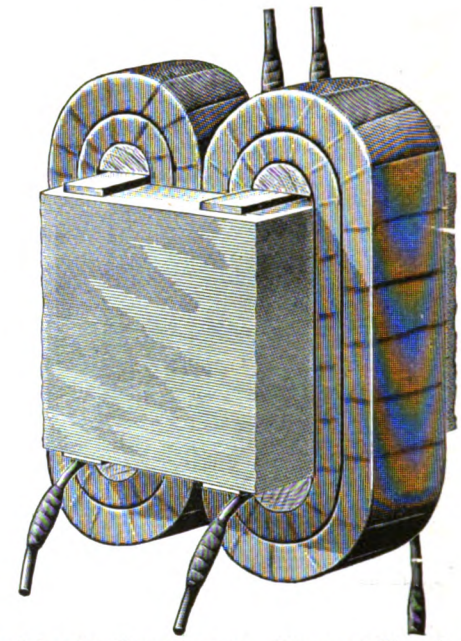
$$\frac{76}{7} = 10\frac{6}{7},$$

extracting the square root gives us 3.29 amperes. In practice this value is accepted as the nearest approximation, and is used in ordinary calculations.

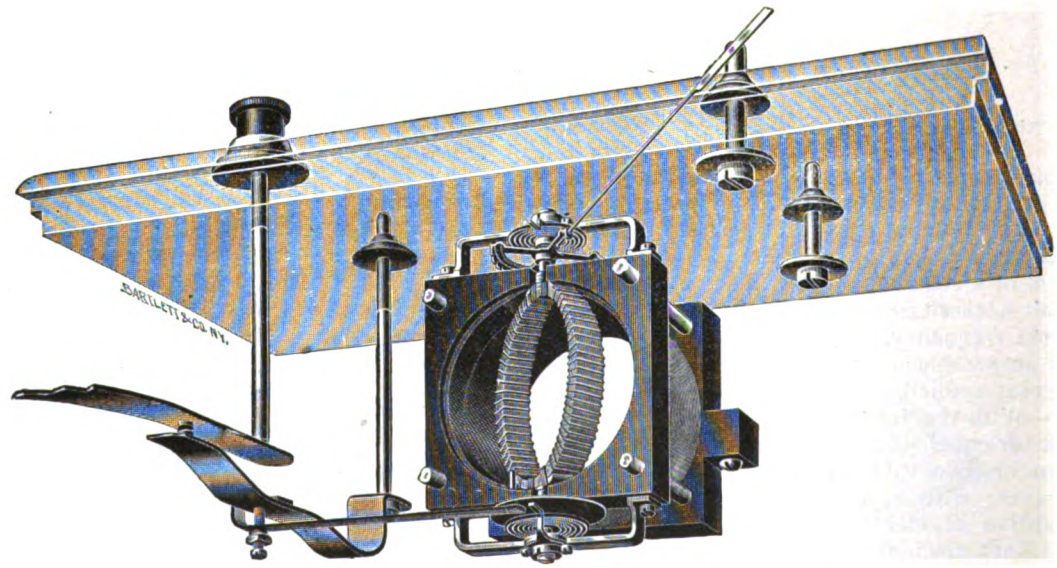
(2.) The different values of the current does not prevent the instrument maker from constructing meters which will measure the "square root of the mean square." The pulsations of an arc-light current practically consist of a series of waves always passing onward in one direction, but virtually similar in general appearance to an alternating wave. The rapidity with which a series of alternations pass back and forth is productive of several strange effects. A piece of metal of any description when thus influenced becomes warm and possibly very hot. When a coil of wire containing a core of iron is magnetized and demagnetized by an alternating current a peculiar hum is heard. The more rapidly the current reverses the louder the hum, until its resonant sound is like a low musical tone. The iron within the core will become very warm and have a curious effect upon a piece of metal placed near it, repelling it with considerable force and likewise exciting heat in it. The explanation given of the effect produced in iron is twofold.



Systems of Alternating Current Distribution.



The Scheeffer Transformer. Diamond Electric Co.



Mechanism of Alternating Voltmeter.

This value, 2.57 amperes, is called the mean current.

Square Root of the Mean Square.—Another method is that of taking the same measurements, squaring each result, taking the average of the squares, and then taking its square root. The process with the same figures would be that of squaring

1 = 1
2 = 4
4 = 16
6 = 36
4 = 16
2 = 4
0 = 0

Taking the average square, 76

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COMPETITIVE ILLUMINATION.

At the rate of $1.25 per thousand cubic feet of gas, the general public are well content to continue its use without evincing any strong desire to avail themselves of more improved methods of lighting. Compared with this, we find oil and electricity in great demand, and even promotors of acetylene pushing their way forward. At the Electrical Exhibition, MacFarlan Moore shows a method of producing artificial daylight on demand. If it were not for the fact that all inventions are weighed from a dollars-and-cents standpoint, as well as the methods involved in their use, all improvements in the illumination of homes would be as popular and widespread as the various grades of bicycles. But the public desire a return for every investment they make, equal to, if not better than, the last.

We would suggest, therefore, that they be advised of the true state of the art of artificial illumination by publishing the reports of a test made with all known systems of any commercial importance, with the cost, candle-power, convenience of each, etc., succinctly set forth.

Each method of illumination finds a place best adapted to its use, and it therefore follows that neither the arc, incandescent light, or the vacuum tube shall reign supreme. "Each in its proper place is best," depending entirely upon the requirements and circumstances brought into view by a proper analysis of the situation.

FORGING BY ELECTRICITY.

There have been many occasions in which it has seemed impossible to introduce to the commercial world an article of pronounced value owing to the circumstances that affect its application. In reviewing the history of invention the interdependence of one upon the other, and the wonderful development in that field may be traced to the increased advantages of those seeking original paths or striving to improve upon devices already in vogue. The electric forge has been acknowledged by authorities to be an exceedingly economical, convenient and consequently practical invention, but there is no evidence in this city that its use is being as well appreciated as at Buffalo or Niagara City. The ordinary blacksmith, as a rule, has no higher ambition than the earning of his living. The forge, its heap of coke, smoky smell and other familiar features has not varied essentially from its earliest prototype used in the days of Tubal Cain. The blacksmith himself seems to have relinquished his right to make further progress, and it therefore seems evident that advances in that line must be made by others who have seen in the improvement of his forge a series of decided benefits that will cause a revolution in so ancient a field of work. The Burton Electric Forge finds its use for brazing, forging and welding as well as the tempering of tools. No better way can be devised for producing a uniform temperature in a piece of metal than this. It simply consists of a wooden trough supported on four legs, carrying a plate of metal on the bottom connected to an out-running wire, and pair of tongs attached to the other wire. The liquid in the trough is an aqueous solution of sodium carbonate and borax having a specific gravity of 10.5. The rapidity with which a one-inch bar one foot long is heated cherry red is fifty seconds, the current required being twenty-six amperes. A half inch bar turns white hot in eighteen seconds with a current of ten amperes and 220 volts. The beauty of this contrivance and its remarkable value is due to the manner in which the current automatically regulates itself according to the size of the material being heated.

Also, the ease with which the heat can be regulated appeals very strongly to the practical iron worker. The oxydation is less, the heating quicker and the cost less than by the old fashioned method. The further use of the electric forge depends entirely upon the business enterprise of those owning patent rights and in control of these rights for certain districts. Although Buffalo and Niagara and even Rochester depend for their source of power upon electricity, and may be truly called electrical towns, New York City will in the course of a few years show so extensive a use of this agent that it will be noted throughout the civilized world as the centre of all innovations, and not the least among these will be the electric forge.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

The Trunk Line Association, Central Traffic Association, New England Passenger Assocation, Southern Passenger Association and the Western Passenger Association, have granted a rate of a fare and one-third, on the certificate plan, from all points in their territory to Chicago and return, for delegates attending the twenty-first convention of the National Electric Light Association, to be held June 7, 8, 9; Convention hall and headquarters at the Auditorium Hotel. Rates: $3.50 to $5 per day on the American plan; $2 to $4 per day on the European plan for each person.

NEW YORK ELECTRICAL SOCIETY.

The 187th Meeting was held in the Concert Hall, Madison Square Garden, on Thursday, 12th inst., at 8:20 p. m. After a short session for the transaction of current business, at 8:30, Dr. Schuyler S. Wheeler lectured on "Electrically Driven Machinery."

The lecture was illustrated by experiments and lantern slides. The evolution of Electrical Machinery, as influenced by the gradual change from belt driving to electric driving was traced, and the modifications of design making for greater simplicity thus rendered possible was demonstrated.

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First.—It is observed that the magnetization consumes power. A piece of iron magnetized by a current flowing in one direction will consume more power to bring it back again to a neutral condition than it did in becoming magnetic. This consumption of power is called hysteresis, and is due to a certain molecular condition causing a rigidity of the particles and therefore depending upon the quality of the iron for its extent. A piece of steel would consume more power than soft wrought-iron while undergoing the process of magnetization and demagnetization; a well annealed piece of iron, less than the ordinary wrought-iron not treated in this manner. Mr. Kapp has given figures on the amount of energy consumed in a mass of iron by hysteresis. The reversals occurred 100 times per second, giving 200 changes. These results are true for the iron of a transformer.

(At 100 complete periods a second.)

Lines of force in iron.	Volts per ton of iron.	Horse-power wasted in heat per ton of iron.
2,000	650	.87
3,000	1,100	1.48
4,000	1,650	2.21
5,000	2,250	3.02
6,000	2,900	3.89
7,000	3,750	5.03
8,000	4,450	5.97
9,000	5,500	7.43
10,000	6,650	8.90

This phenomenon called hysteresis will have such an effect upon the iron that only after the magnetizing force has been partially removed the influence steals over the iron and develops lines of force. A difference of phase, therefore, exists between the magnetizing force and the lines of force produced, or what might be called the resultant magnetization. The other effeet acting upon the iron is much simpler in its nature. It is due to eddy currents, small whirling currents induced in the iron by the fact that lines of force are cutting it, passing and repassing so rapidly that an electromotive force is set up and necessarily a current. To avoid these eddy currents the iron is subdivided into thin sheets or used in the form of wire. This treatment will not in the least reduce the hysteresis, as that is entirely due to the molecular condition of the iron, but will reduce the eddies by insulating the parts of the metal from each other. The currents then produced have so short a circuit to flow in that their volume is very slight and the heat very little. The hysteresis in iron depends upon the extent to which it is magnetized and naturally upon the rapidity with which these changes occur. These, in addition to the fact that it likewise depends upon the quality of the iron, enable us to reduce or increase it at will or hold it well in check. The importance of understanding these effects and their causes is clearly seen in the design of a transformer. A transformer is a device by means of which a given electromotive force can be increased or decreased.

There are two classes of transformers:

Step-up transformers,
Step-down transformers.

In city circuits the step-down transformer is generally used. A pressure varying from 1,000 to 2,000 volts is applied to it and reduced down for purposes of light or power to 50 or 100 volts as required. The transformer consists of a frame of iron upon which are placed two coils of wire. The coils link in with a complete magnetic circuit formed by the iron. The iron is generally used in thin plates and the two coils thoroughly insulated from it and each other are linked by it. Thus, there may be a circle of iron and a coil on each side of it at the opposite extremities of a diameter. The resistance and turns of each coil are duly proportioned to receive and give individually the proper current and pressure.

The iron being continually subject to violent reversals, must create the least possible heat and absorb little or no power. To do this both the hysteresis and eddy currents must be kept down to a certain low but definite value.

(3.) To design a transformer to meet the demands of practice, the conditions of practice must be considered in full. An induction coil and a transformer merely differ in detail; they are identical in principle.

Construction.—A transformer consists of a closed magnetic circuit and two coils of wire. The coil connecting to the source of current is called the primary, and that in circuit with the line or lights the secondary. In commercial lighting the primary is fed with a current of about 2,000 volts; the secondary delivers the same amount of energy minus loss, at 50 volts. It is natural that the transformer, like any other piece of apparatus, should be of a size consistent with the service it is to perform. Transformers are therefore rated as 5-light, 10-light, 50-light, 100-light, etc. The weight of iron and copper also increases with the number of lights supplied.

Design.—The iron and copper used in definite proportions will give the best effects, provided they are of the quality used by large companies. That is, the iron must be of the softest kind and the copper pure. The size of a transformer then depends upon the number of lines of force it contains. In the case at hand, if the number of lines of force per square inch be too high, hysteresis will heat and endanger the construction. It is necessary that the magnetic induction be kept very low; from 8,000 to 12,000 lines of force per square inch, or higher if the designer sees fit. The previous table will give an idea of the losses entailed with higher induction.

Having determined to keep the induction low, the ampere turns required and the weight of copper come into consideration. The rule for calculating the turns is simple, the primary and secondary being individually treated. If the primary receives 2,000 volts and the secondary reduces it down to 50 volts, the ratio between them is 2,000 : 50, or 40 : 1.

This ratio of 40 : 1 represents the proportion existing between the turns on primary and secondary.

Each turn on the secondary is counterbalanced by 40 on the primary. The rule for keeping this fact in mind is

$$\frac{\text{E. M. F. Secondary}}{\text{E. M. F. Primary}} = \frac{\text{Turns Secondary.}}{\text{Turns primary.}}$$

The method of calculating the turns on the primary is as follows:

$$\text{E. M. F.} = \frac{\text{Turns} \times \text{Lines force} \times \text{frequency.}}{100{,}000{,}000}$$

The arbitrarily adopted factors are the turns and lines of force. The frequency is from 100 to 150 at the utmost. To illustrate the above, take a case as follows: A dynamo producing 2,000 volts is to be connected to a transformer which will reduce it down to 50 volts; we now have

$$2{,}000 = \frac{\text{Turns} \times \text{Lines force} \times \text{frequency.}}{100{,}000{,}000}$$

Adopting a frequency of 100 per second the above becomes

$$2{,}000 = \frac{\text{Turns} \times \text{Lines force} \times 100}{1{,}000{,}000}$$

Adopting 1,000,000 lines of force, we have

$$2{,}000 = \frac{\text{Turns} \times 1{,}000{,}000 \times 100}{100{,}000{,}000,}$$

which gives us 2,000 turns with that frequency and induction required. The reduction of turns for the secondary follows in proportion of the pressures. The secondary in this case requiring one-fortieth as many turns; that is to say, 50. When the transformer is at full load the current circulates freely in the primary coil, and

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therefore in the secondary. When the load is off, the primary being always in circuit, still receives current, but to a very slight degree. The current passing through the primary increases automatically with the demands made upon the secondary. When the lights are gradually turned on, the secondary uses more current; the primary being sensitive to these conditions, receives more, and thus keeps up without interruption the cycle of changes. Large power plants have been erected abroad and in this country that use this system of transformation and transmission. The Ferranti system in London is one of the greatest in the world.

QUESTIONS FOR REVIEW.

(1) What is meant by the term synchronism ?

(2) What is a rotary field ?

(3) In what respect does a polyphase current differ from a single-phase ?

(4) How is the true value of the current measured ?

(5) Why does hysteresis affect the efficiency of a transformer ?

(6) With an E. M. F. in primary of 2,000 volts and 1,000 turns, how many turns are required for the development of 100 volts ?

THE DEVELOPMENT OF ELECTRICAL SCIENCE.

(Continued from page 247.)

The method of producing the currents in Gauss' and Weber's experiments was an application of the important discoveries of Faraday and Henry, above referred to, in the induction of current by currents and by magnets.

On the recommendation of Gauss, this telegraph was taken up by Stenheil, who, following their example, also used induced currents. The important contributions of Steinheil were the discovery of the earth return circuit, the invention of a telegraphic alphabet and a recording telegraph. Steinheil contributes an account of his telegraph to Sturgeon's Annals of Electricity, in which the relative merits of scopic, recording and acoustic telegraph are discussed, and the advantages, which experience has since brought into prominence, of the acoustic form are pointed out.

Schiller's telegraph was exhibited at a meeting of German naturalists held at Bonn in 1835, and was there seen by Professor Muncke, of Heidelberg, who, after his return to Heidelberg, made models of the telegraph and exhibited them in his class-room. These models were seen by Cooke in the early part of 1836, and gave him the idea of introducing the electric telegraph in England. Cooke afterward became associated with Wheatstone, and a large number of ingenious arrangements for telegraphing was the result. Many of the later developments by Wheatstone are still in use and are hard to beat.

Steinheil appears to have been anticipated in the idea of making the telegraph self-recording by Morse, who, according to evidence brought forward by himself, thought out some arrangements as early as 1832. Exactly what Morse's first ideas were seems somewhat doubtful, and he did nothing till 1835, when he made a rough model of an electro-magnetic recording telegraph. Morse's mechanical arrangements were of little merit, and his alphabet and method of interpretation by a dictionary were clumsy and inconvenient. The chief point of interest in connection with the early history of the Morse telegraph was the proposal to make use of Sturgeon's discovery, of electro-magnetism of soft iron. Morse, however, seems to have known practically nothing of the subject except that iron could be magnetized by a current, and in consulting his colleague, Dr. Gale, he was unwittingly led to use the discoveries of Henry, who had previously practically solved the whole problem. Much of the subsequent improvement in the mechanical arrangements were due to Vail, who became associated with Morse, and the Morse code as we now know it was almost, if not entirely, worked out by Vail. Considerable dispute and some litigation arose over Morse's claims, but that is outside our present subject. There is no doubt that the electric telegraph was a slow-growth invention, with a view to pecuniary and other advantage, being ever ready to lay hold of each scientific discovery and try to turn it to account. The question who first conceived the idea can never be satisfactorily answered.

After 1840, there is little to record of a purely electrical character bearing only on telegraphy, but there have been many very ingenious mechanical contrivances introduced for recording signals, for reproducing pictures and handwriting and for printing, for duplexing, quadruplexing and multiplexing telegraph lines, for increasing the rate of signalling and in many ways increasing the expedition with which messages can be sent. Of course, the success of many of these contrivances, and even their invention, depended upon an increased knowledge of the laws of electricity and magnetism. For example, effective duplexing, quadruplexing, etc., depends on a proper understanding of the electrostatic capacity of the line, and this was not understood properly until the mathematical investigations of Thomson and others cleared the matter. For the impetus towards discovery in this direction again we are largely indebted to telegraphy, for much of that class of work was suggested by the difficulties encountered in the signalling through long submarine cables.

The invention of the telephone is fast becoming ancient history, and yet it will always mark one of the greatest of the useful applications of electricity. It does not call for more than a passing remark here, because electromagnetically it is all in Faraday's and Henry's papers.

The radiophone should be mentioned because it marks the application of the discovery, by May and Smith, of the effect of light on the resistance of selenium. This effect has since been found in the case of a large number of other substances, but it is still an interesting field for research. A number of experiments on this subject have been associated with attempts to make things visible at a distance. No doubt it will ultimately be possible not only to talk to a distant party, but also to see the party talked to, and thus, as it were, look the party with whom you are conversing in the eye.

(To be continued.)

THE GREAT ARCOLIER lighting the Electric Show is the wonder of this electrical age. It is composed of 37 small enclosed arc lamps aggregating 40,000 candlepower, all of which is the conception of MR. GEORGE R. MACINTIRE, the electrical engineer and designer of the INTERNATIONAL ARC LAMP CO., of Mercer and Houston streets, N. Y. The beauty of this fixture is like a well-formed lady, when the boy said, "get on to her curves." We may say in this instance in all sincerity that the curves on this arcolier are really beautiful. The whole fixture weighs 1,500 pounds and must be seen to be appreciated.

A VERY FINE contract has been placed with Cleveland & Taylor, the electrical contractors of 5 Dey street. They will equip the fine new Fletcher residence, 79th street and Fifth avenue, N. Y., with electric light, burglar alarms, speaking tubes, bells, gas lighting, etc; the installation calls for Montauk Multiphase Cables. These cables are constantly thermostatic throughout the whole line and are a constant safeguard, giving alarm of fire at all times in case of fire. Cleveland & Taylor are experts on burglar-alarm work.

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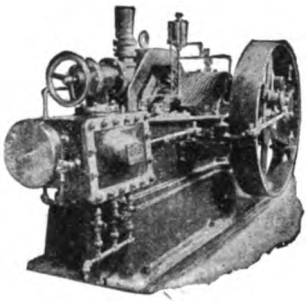
MADISON SQUARE GARDEN.

LECTRICAL EXHIBITION shone in one radiant gleam of soft white light every night this week, and every tourist present was well pleased with his visit. We went into a long account of exhibits on the main floor in our last issue. This issue will tell you what we saw in the busy whirl of the dynamos and engines down stairs. The Babcock & Wilcox boilers generate hundreds of horse power in dry steam, which is carried in covered pipes to a number of complete plants, among whom we mention the Woodbury 25 K. W. automatic cut-off engine, direct-connected to 25 K. W. Eddy dynamo, with switchboard and switches connecting with the main circuit of the Garden, and in the care of Mr. L. A. Comacho, representing Messrs. Burhorn & Granger, the agents, 136 Liberty street, New York.



draft for boilers, one of which was in full operation in connection with the Babcock & Wilcox boilers in the Garden. These machines are made by the Kensington Engine Co., of Philadelphia.

H. H. LINDEMUTH described the fuel economizer on exhibition, made by Broomwell, Schmidt & Co., York, Pa. One of the economizers was in full operation.

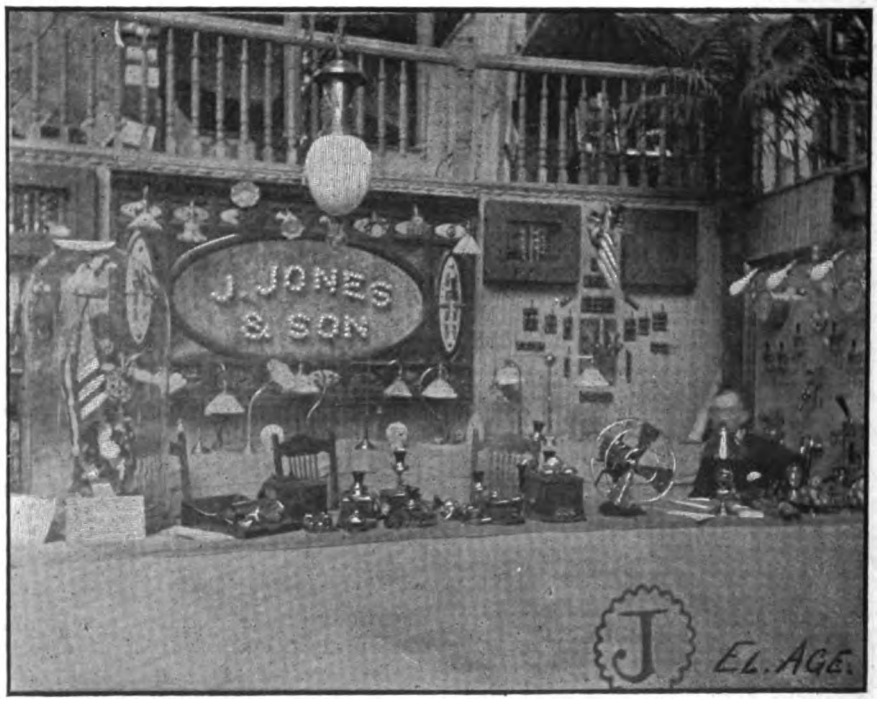
THE DIESEL MOTOR running a C. & C. 30 K. W. dynamo attracted considerable attention. They claim no direct combustion or explosion. The high compression of air, it is claimed, ignites the plain kerosene used in operating these engines. A reservoir of compressed air starts the engine.

THE DE LA VERGNE REFRIGERATING CO., of N. Y., exhibited several sizes up to 32 H. P. Hornsby-Akroyd oil engines. One of 4 horse power was belted to a C. & C. dynamo, and operating the lights in their exhibit. Mr. E. H. Cox was in charge of this exhibit.

J. JONES & SON, of 64 Cortlandt street, attracted large crowds to their beautiful exhibit. They have a full line of switch and panel boards, and a great variety of electrical goods. Miss Liberty, in a glass case, is the attraction. The young Miss getting the largest number of votes receives this elegantly-dressed doll. It is all enclosed in a glass case. With the use of a frictional machine Mr. Jones makes the doll's hair stand on end or raises it from its head.

THE BULLOCK ELECTRIC CO., of Cincinnati and St. Paul Building, N. Y., installed a number of their fine multipolar dynamos and motors this week. They were delayed in shipment. Mr. Lozier, the manager, assisted by Messrs. Oakman, McLean and others, held levees all the week.

THE MONTAUK MULTIPHASE CABLE COMPANY, of 100 Broadway, New York city, exhibit their famous thermostatic multiphase cable. Messrs. Price and Gould show its unique qualities to thousands of



J. Jones & Son Exhibit at Electric Show.

NEW YORK SAFETY STEAM POWER CO., of 107 Liberty street, N. Y., exhibit their improved 120-H. P. vertical automatic cut-off engine direct-connected to a Fort Wayne 65 K. W. generator, with switchboard, switches, and Weston meters furnishing current to the exhibitors.

ROBERT T. MICKEL explained the advantages of one of the Beekman automatic-control under-grate

sight-seers. This cable has attracted considerable attention and is regarded as an excellent protective device.

THE CROCKER-WHEELER ELECTRIC COMPANY, of 39 Cortlandt street, New York city, have a central exhibition in charge of Blackall & Baldwin. Many types of dynamos and motors of various sizes are arranged for inspection, and a massive multipolar generator has been installed in the middle of the exhibit.

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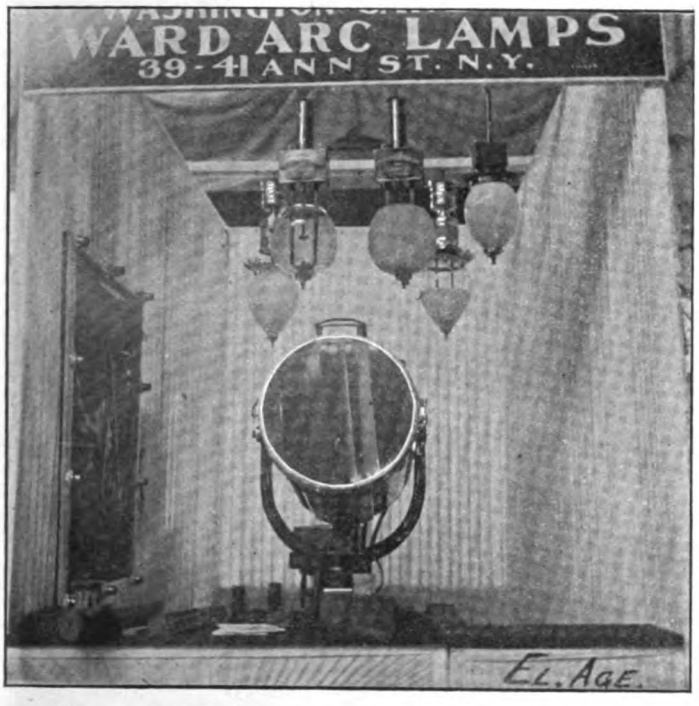
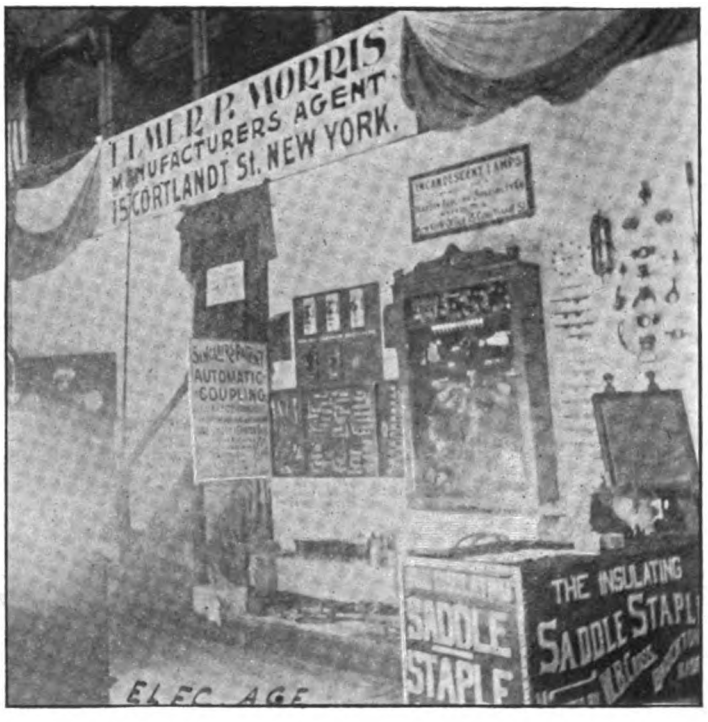
THE WARD ELECTRIC SUPPLY AND CONSTRUCTION CO., of 39-41 Ann street, New York city, have a large line of arc and search lights in their booth. Mr. Deronda Levy, the manager, is a well-known and well-liked contracting engineer, whose efforts on behalf of the Electrical Exhibition Company are worthy of great praise.

HARING STEAM PLANT EQUIPMENT CO., Washington Life Building, exhibits 280 H. P. Armington & Sons Co. Automatic Engine, direct connected to a 50 k. w. Walker Generator.

F. A. LA ROCHE built the main switchboard for the Exhibition current, giving 110 volts and up to 3,500 amperes, five Weston voltmeters, six ammeters, four dynamo

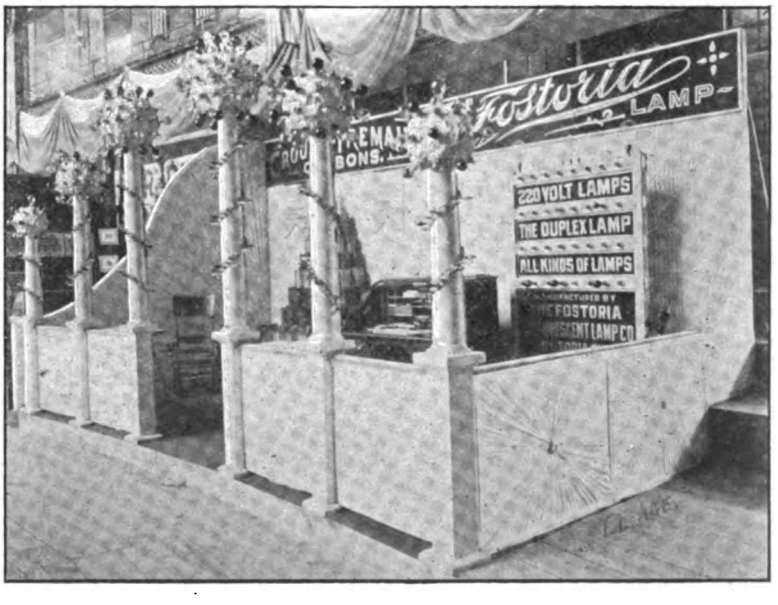


"Ward" Electric Supply & Construction Co.'s Exhibit.



Elmer P, Morris' Exhibit.

Otis Brothers & Co. and H. B. Coho & Co.



Fostoria Lamps and Crouse-Tremaine Carbons.

THE FISCHER FOUNDRY AND MACHINE CO., of Pittsburg, Pa., exhibit one of their 125 H. P. Tandem Compound Engines, direct connected to an Onondaga, N. Y., dynamo, with switchboard, switches, Weston instruments, etc., furnishing current to the exhibitors. Mr. F. H. Sheppard has charge of the dynamo for the agents, Messrs. Fairchild & Summer, 39 Cortlandt street. Messrs. Porter & Remsen, of 39 Cortlandt street, N. Y., represent the engine makers.

switches, one Edison service switch, one switch connecting the Madison Square Garden plant, six feeder switches fitted on marble and marbleized slate board, all connecting with the various auxiliary plants on exhibition and connecting with the lighting effects and illumination in the Garden.

A 30 H. P. NASH GAS ENGINE was shown, direct connected to a Walker dynamo exhibited by the National Meter Co. of N. Y.

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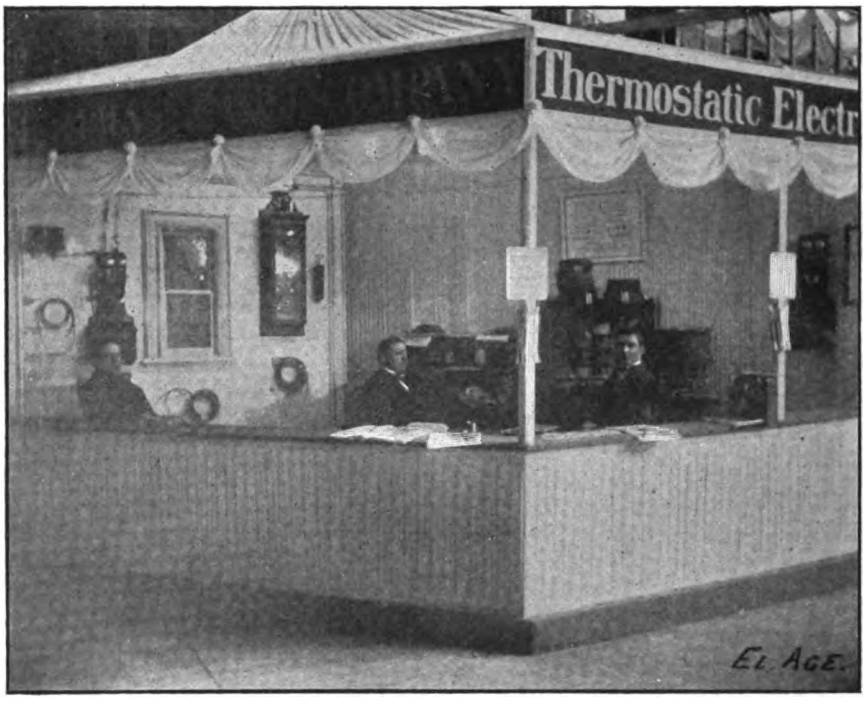
MR. ALBERT CARY, M. E., of the Monarch Mfg. Co., 39 Cortlandt street, N. Y., inventor of the Monarch Engine Stop and Automatie Speed Limit, shows several sizes of these simple and practical machines. We will illustrate and describe these excellent machines in an early issue.

THE FOSTORIA LAMP COMPANY, of Fostoria, Ohio, have ornamented their booth with a large and beautiful cluster of lamps mounted on pillars and decorated with winding wreaths of many-hued miniatures.

About the middle of the great hall, to the left, is an exhibit of Otis Brothers and Coho & Company. The Otis



Montauk Multiphase Cable Co.

C. D. MAYRE represents the Nonpareil Cork Mfg. Co., of Bridgeport, Conn. and N. Y., showing a large line of steam-pipe covered with their cork-sectional covering and cork-covered cold-storage pipe.

ALBANY GREASE AND GREASE CUPS, in all styles and quantities, were exhibited and under the supervision of Mr. A. J. Squier. This grease is greatly used in electric light and power plants, and Adam Cook's Sons, of 313 West street, N. Y., are the makers.

THE FOSTORIA INCANDESCENT LAMP CO., of Fostoria, Ohio, manufacturers of all Standard Incandescent Lamps, exhibit a full line of them in their handsome booth at the Electric Show. Mr. H. Stillson Hart, the N. Y. representative, with offices at 726 Broadway, is deserving of great credit for the manner in which he fitted up his company's exhibit at the Garden. Special attention is called to their new line of 220-volt lamps shown on a handsome board in the back of their exhibit. You must observe the line of beautiful colored miniature and standard lamps of all styles and sizes on the columns and globes that top off the pillars in front of the exhibit.

MR. ELMER P. MORRIS, 15 Cortlandt street, New exhibits a big line of specialties in card motors and dynamos, Keystone electrical instruments, Garton Daniel's lightning arresters, anti-trust lamps, switchboards and switchboard fittings, soldering compound, Forest City bonds, commutators, a full line of railway material, and the Monarch insulating paint, the best in the world for dynamos, motors, etc. The X Rays shown up the little stairs in his exhibit are very attractive to visitors.

AMERICAN ENGINE CO. of Bound Brook, N. J., exhibit one of their latest styles of Horizontal Automatic Engines, direct connected to one of their own 25 k. w. dynamos with switchboard, switches, Weston instruments, etc., furnishing current to exhibitors. Mr. F. H. Ball, vice-president, assisted by Mr. Fred. Ball and Mr. W. K. Bassford, their electrician, furnished visitors with the data relating to their specialties.

home elevator is shown to great advantage. The car within is sent up to any floor by pressing a button, and it may be brought to any landing by a person outside in the same manner. It represents perfection and relieves the operator of all possible doubts or sense of insecurity.

MESSRS. H. B. COHO & COMPANY show a fine line of light and power machines. They handle the Eddy dynamo, as well as the well-known Eddy plater, one of which is shown there with a double commutator for two pressures.

A VERY ATTRACTIVE exhibit to bicycle riders is the Pilot Electric Light made by the DOWD ELECTRIC CO., of Boston. It is a very finely-made little dynamo that can be fastened to the front of a bicycle and run on the rubber tire of the front wheel. It gives a very brilliant light. Mr. G. M. Port has charge of the exhibit at the Electric Show.

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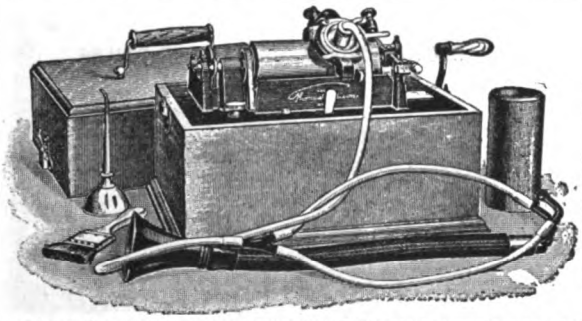

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goes to press June 1st. To obtain the advantage of listing in this issue it will be necessary to make contracts during the present month.

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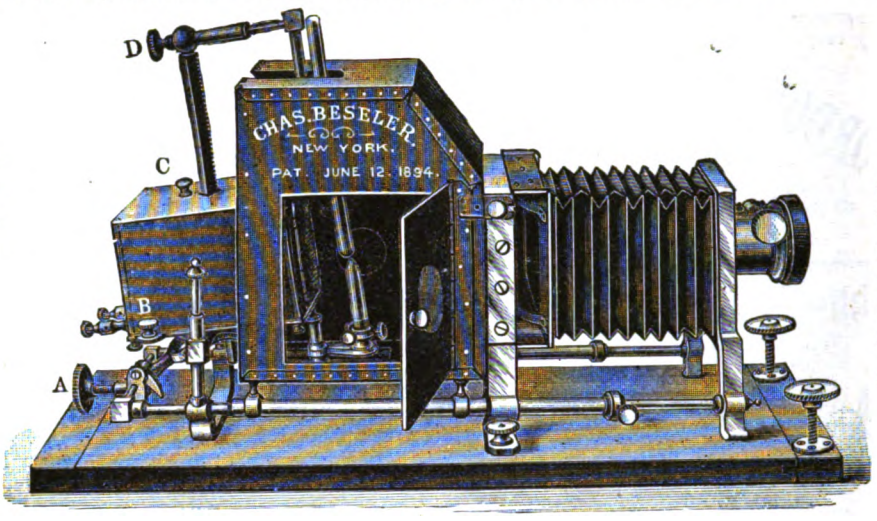

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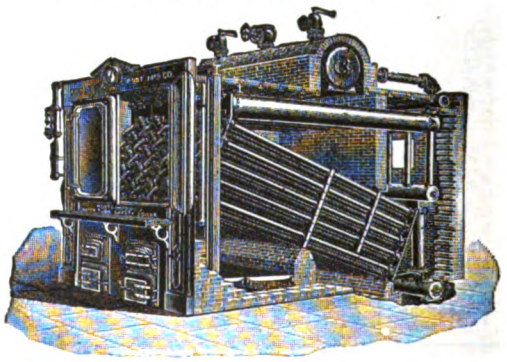

Selected by leading Electric Light Plants and Street Railway Companies throughout the United States. The following are the acknowledged requirements in water-tube boilers: *Straight tubes which can be thoroughly inspected and cleaned inside and outside; perfect suspension, allowing free movement of whole boiler expanding and contracting; perfect flexibility for the difference in expansion between upper and lower tubes; interchangeable parts, built to fixed standards; facilities for making quick and easy repairs which can be done by your own engineer or machinist; a cover joint which can easily be made tight, and frequently broken and replaced without injury; provision made to introduce the feed water where it will not chill and moisten the steam; provision made to carry feed water impurities direct to the mud drum and not past the ends of the tubes; provision made to supply the lower tubes with a bountiful supply of cool water; the use of the best materials and fittings the market can afford; the best possible workmanship; a large disengaging surface for the steam to escape from the water; small cast iron pressure parts; ample heating surface to prevent injury to parts should boiler be forced above its rating.*

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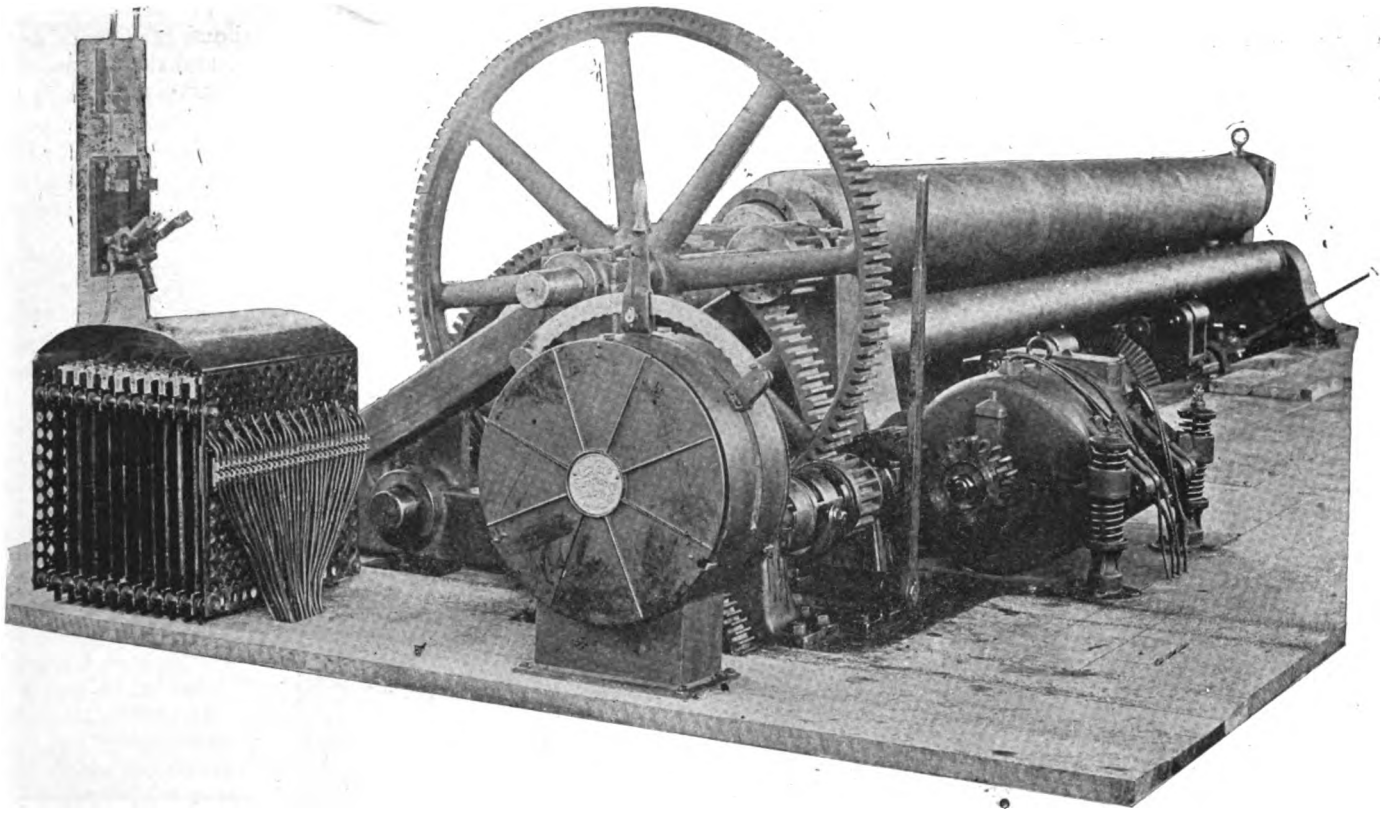
The Electrical Age.

VOL. XXI—No. 21 NEW YORK, MAY 21, 1898 WHOLE NO. 575



30 H. P. Motor Driving a 20 Ft. Bending Rolls.

THE ELECTRIC MOTOR FOR HEAVY MILL WORK.

The electric motor has shown its value for heavy mill work in the boiler shops of the Aultman & Taylor Machinery Company, of Mansfield, O. The equipment consists of a 30-H. P. mill type motor, manufactured by the Card Electric Company, of Mansfield, O , driving power-bending rolls capable of bending boiler-plate twenty feet long by one-quarter of an inch thick. This 30-H. P. motor runs at a speed of 325 revolutions per minute at full load. The motor and bending rolls are direct-connected by gears. Controllers exercised by means of a clutch, which, through the medium of a vertical lever, sets into operation two trains of gearing, optionally; one set throwing the two lower rolls into use, the other the upper one. The ready reversibility of the motor enables the operator to bend plates to any circle with accuracy and ease. The electrical details are as follows:

A controller of the standard R type, made by the Card Electric Company, affects an easy management of the motor. The current regulator is built up of iron wire with sufficient capacity to carry the full current of the motor at full load, irrespective of the speed. There is enough resistance in the current regulator to allow ready reversing under all circumstances. As seen in the illustration, this motor is mounted on springs, thereby allowing sufficient movement of the motor to avoid the inevitable shock due to sudden reversing or the throwing on of the load.

The great advantages of this combination appeal very strongly to the practical mind, for by this method of connecting the source of power to the machine a cushioning takes place with every variation in load and a certain automatic elasticity exists, which saves both motor and bending rolls from considerable injury. It has already been admitted by mechanical experts that the application of direct-connected machines is the best the world affords, and in this case, as in many others, the utmost satisfaction prevails through the economical operation, convenience and certainty of action resulting from this arrangement.

The Card Electric Company have made a great success of all their heavy machine installations, their experience and careful attention to every detail giving them prominence in the eyes of many manufacturers.

BURNING LOW GRADES OF FUEL.

The methods in vogue at present for burning low grades of fuel are, generally speaking, of two kinds. First, that of mixing the low-grade with high-grade fuel; second, that of using a forced draught. The Beckman system is of this latter order, and consists of a blower with engine and regulating valves. The engine and blower may be either belted together or direct-connected. The regulating valve is placed on the steam inlet pipe to engine blower. A pressure-reducing valve is in series with the regulating valve, controlling the speed of fan and pressure of air. Under the grates an opening in the bridge wall allows the air to enter, the pressure being one ounce or less. A damper hinged to the bridge wall deflects the air so that it passes away in the same direction as the draught induced by natural conditions. A great saving of fuel or, at least, its cost, results from this device.

The Beckman system of automatic regulation removes all possible objections to its introduction and proves its remarkable convenience and excellence, all operations being automatic in this particular method. At the Electrical Show the boilers on the lower floor have their fires fed with air by the Beckman system. Its success there is self-evident. The illustration shows a plant of this kind installed by the Kensington Engine Works, Limited, Francis Brothers, proprietors, of 704 Arch street, Philadelphia, Pa., for the Providence Ice Manufacturing Company, of

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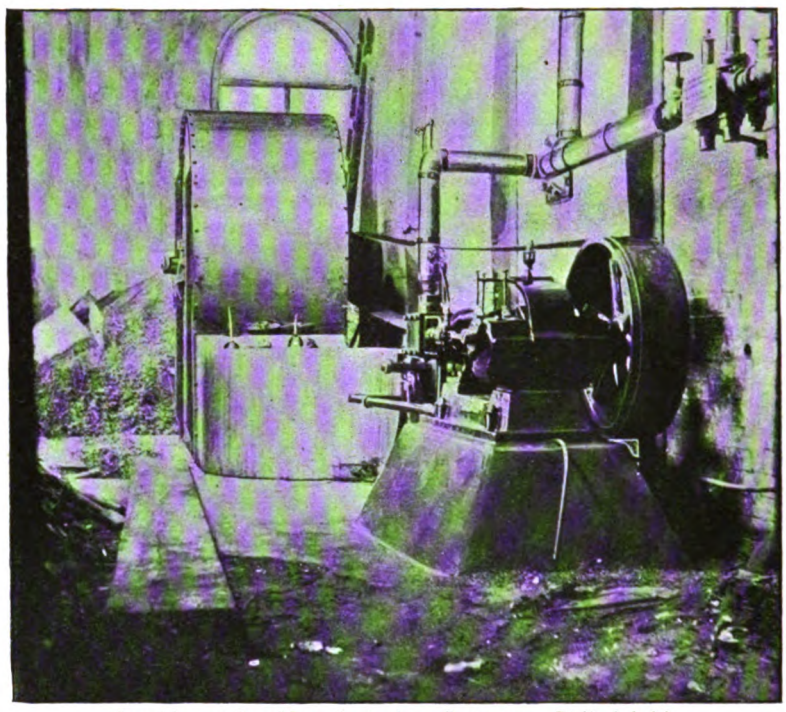
Philadelphia, Pa., the Beckman system of automatic-control, under-grate, mechanical-draught being part of the work engaged in by the Kensington Engine Works, Ltd.

At the Electrical Show Mr. Robert T. Meickle, M. E., will be found in charge of the Beckman exhibit on the lower floor, and will be pleased to answer all questions relating to the cost and operation of the Beckman system.



Providence Ice Manufacturing Company, Philadelphia.

THE DEVELOPMENT OF ELECTRICAL SCIENCE.

(Continued from Page 275.)

The subject of telegraphy is closely associated with the present excellent system of electrical measurements and with theinvention of many of our most delicate measuring instruments. As the applications of electricity increased there gradually grew up a new branch of engineering, a branch, however, in which the foot-rule, pound-weight, chronometer and thermometer were not sufficient. Other standards of measurement were required, in order that quantities could be gauged and consistent work done. The way to connect the measurements of the new quantities with the units already in use in dynamics had been pointed out by Gauss and others, and at the suggestion of Thomson the British Association appointed a committee in 1861 to determine the best standard of electrical resistance. This led to an uxexpected amount of work, not only on a standard of resistance, but also on the gen eral subject of electrical measurement. The committee regretted, at the end of the first year, that it could not give a final report, but hoped that the inherent difficulty and importance of the subject would sufficiently account for the delay. It can hardly be said that the final report has yet been forthcoming, as a committee with some of the original members in it still exists, and reports regularly every year on valuable work done by it. The committee worked energetically for a number of years, not only on the standard of resistance, but on those of current, electromotive force and capacity. It incidentally supplied a great deal of quantitative data on a number of subjects, and particularly as to the permanence of alloys, the variation of their resistance with temperature as depending on their composition and so forth. In looking over the results of the early work of the British Association committee one is apt to indulge in adverse criticism. It is hard for many of the younger workers to appreciate the difficulties which are met in a first attempt. It would be equally just to congratulate ourselves that we have better marksmen to-day than there were fifty years ago, without making allowance for the modern rifle.

The first absolute determination of resistance was probably that made by Kirchhoff about fifty years ago. Weber published his method in 1852, and then came the B. A. determination by Maxwell, Stewart and Jenkins in 1863. Neither of these were very exact, but they paved the way for the splendid exhibitions of experimental skill which followed. Among those to whom we are most indebted for this latter work may be mentioned Kohlrausch, Rayleigh, Glazebrook, Rowland, Wiedmann, Mascart, etc. The greatest step in advance in recent years has been the invention of the revolving disc method by Lorenz of Copenhagen, and its subsequent improvement and application by himself, and by J. V. Jones. The determinations made by the latter by this method are probably almost absolutely correct.

A subject which has attracted much attention comes in incidentally here, namely, the electromagnetic theory of light propagation suggested by Maxwell. According to this theory the ratio of the electromagnetic unit of quantity of electricity to the electrostatic unit, ought to be the same as the velocity of light. In 1868 a determination of this ratio was made by McKichan under Lord Kelvin's direction, and gave close agreement with the theory. Since that time determinations have been made by various methods by Maxwell, Shida, Ayrtin & Perry, J. J. Thomson, Rosa, Lodge, Glazebrook and others, with the result that the ratio of the two units does not differ from the velocity of light by more than the probable error of observation. The work here referred to may not appear to be very directly associated with the determination of standards of measurements. It is, however, one of the investigations which has been made possible by the work of the B. A. committee in the production of instruments of precision. Prominent among these instruments stands the Kelvin electrometers, and particularly the absolute electrometer which was described in the report of the B. A. committee for 1867.

Another subject of great interest in itself and in connection with Maxwell's theory, is that of the specific inductive capacity of dielectrics. Experiments on this subject were made by Faraday, but comparatively little was done before 1870, in which year an excellent paper was communicated to the Royal Society, by Gibson and Barclay,

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on the specific inductive capacity of paraffin. Since that time much good work has been done by Bolzman, Hopkinson, Quincke, Silow, Klemencic, Negreano and others. The theoretical importance of these experiments is due to the fact, that, according to Maxwell's theory, the specific inductive capacity of non-magnetic dielectrics should be proportioned to the squares of their indices of refraction. A wonderful verification of Maxwell's theory was carried out only some ten years ago by Hertz, who showed not only that electrical waves exist, but also how to measure their wave length and period. We have in these experiments splendid illustrations of the oscillatory discharge referred to above, as discovered by Henry and predicted by Thomson, and as a result several new ways of determining electrical quantities have been developed. It is now possible, for example, to compare the capacity of condensers by means of oscillatory currents of exceedingly short periods, and thus to determine the dielectric constants of many materials to which the older methods were not easily applicable.

It is somewhat difficult to decide where to place a reference to the recent Rœntgen and its development in photography, but probably it comes in well here. Just how to apply Maxwell's equation to Rœntgen rays is not yet quite clear, but there is no doubt as to the great importance of the discovery.

As an outcome of all this activity in the determination of standards, and in the absolute measurements of the electrical properties of materials, combined with the great commercial demand produced by the introduction of dynamo-machinery, we have now many excellent instruments at our disposal for absoluie measurement, and suitable either for practical applications or for the mo t refined laboratory work. For the production of these we are indebted to a host of inventors, prominent among whom may be mentioned Lord Kelvin, Lord Rayleigh, Ayrton & Perry, Mather, Swinburne, Cardew and Weston.

(To be continued.)

THE EFFECT OF ARMATURE INDUCTANCE UPON THE ELECTROMOTIVE FORCE CURVES OF AN ATERNATOR.

BY W. E. GOLDSBOROUGH.

The subject of the regulation of alternating dynamo-electric machines, considered as a function of the inductance of their armature coils, has been treated by a number of writers, and during the last few years has attracted much attention.

In looking up the bibliography of the subject, however, I find that but few records have been published of the actual value of the inductance of the generating coils of these machines, and that even less data are available regarding the real nature of the periodic fluctuations that take place in this quantity.

We are indebted to Hopkinson, Ayrton, Kapp, Sumpner, Duncan, Tobey and Walbridge, Reid, Steinmetz, Fleming, Rothert, Roessler and many others for much valuable information touching upon the theory and practice of the design and handling of machines of this type, but these writers, in so far as I am informed, have failed to furnish us with a record of the actual internal relations existing between the factors involved, freed of conventional and restricting assumptions.

With the assistance of Mr. W. N. Motter and Mr. S. R. Fox, I have carried on a series of experiments in the electrical laboratories of Purdue University for the purpose of investigating the subject.

APPARATUS AND METHOD EMPLOYED.

The experiments which I shall describe were made upon a three-light Brush arc machine fitted with the necessary exploring coils, collector rings and revolving contact-making device. The machine was selected on account of the peculiarities of its design. These were particularly valuable, as the end sought was to obtain results of an exaggerated nature in order that the factors entering into the problem could be brought into bold relief and thereby lend themselves to more ready investigation.

The core of the armature is of the ring type and is built up of laminated iron stampings, held together by laminated iron bands passing around the core between the successive layers of stampings. Each stamping, therefore, forms a portion of the surface of a cylinder having its axis coincident with the axis of rotation. The stampings are shaped so as to make sixteen large teeth of trapezoidal section, which project laterally from the core, there being eight on each side. The armature winding is composed of eight coils or bobbins of 286 turns each. The bobbins on opposite sides of the armature are connected in series, and their free ends brought out to one pair of the eight commutator segments. Previous to making the experiments, all of the copper commutator segments were removed, and two cast-iron collector rings substituted for them. Fig. 1 shows the machine with these in position, and the collecting brushes in place. Each ring was connected electrically to one of a pair of commutator segment terminals, to which the free ends of one pair of the armature bobbins were fastened. The rings were then carefully insulated from contact with all the other commutator terminals. As the armature is of the open coil type, each commutator segment is attached to the terminal of but one coil, and therefore, by the arrangement described, the arc machine was converted into a two coil alternator. Throughout the test the remaining six coils were practically dead, being cut out and left on open circuit.

Owing to the fact that the armature bobbins are wound between large projecting teeth, and since the clearance spaces between the teeth and the pole faces are relatively small, the inductance of the coils is high. The coils are practically buried in iron, and the leakage of the magnetic lines of force set up in them is slight. There are in all 16 teeth on the armature core, or 4 to each pole face. As the armature revolves, there are alternatively 3 and then 4 teeth opposite each pole face. The latter condition occurs when two of the coils take up positions midway between the pole corners, as, for instance, coils 1 and 2 in Fig. 2. The former when four of the teeth reach positions midway between the pole corners N, S, and N, S'. The reluctance of the path of the magnetic flux through the field frame and the armature core is therefore a variable quantity, and pulsates between its maximum and minimum values eight times during each revolution of the armature.

The four field exciting coils are connected in series in such a way as to form like magnetic poles facing one another, on the same side of the armature shaft. By this arrangement the lines of force entering the armature core from abutting pole-pieces repel one another, and dividing, penetrate the armature core above and below the shaft in a direction perpendicular to a vertical plane passed through the centre of rotation and parallel to the shaft. When the armature core is at rest, therefore, and the field coils separately excited, the field flux passing through any pair of armature coils will be a maximum when they are in positions 1, 2, Fig. 2, and will be zero when they are in positions 5, 6.

The method employed in making determinations of the self-induction of the armature was as follows:

An exploring coil of 42 turns of No. 36 B. & S. copper wire was wound over armature coil 1, and connected in series with the field coils of a high-resistance Nalder ballistic galvanometer and an adjustable non-inductive resistance. A constant exciting current of ten amperes was kept flowing through the field circuit at all times. During the time of taking any one set of readings, a direct cur-

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rent of definite value was maintained in coils 1 and 2 except when the deflections were made. In circuit with the two armature coils and the source of power were connected a Weston ammeter, the primary of the calibrating coil of the ballistic galvanometer and a snap switch. The snap switch, being actuated by a spring, gave exactly the same form of mechanical "make" and "break" of the current at each reading. Readings were taken when making and when breaking the current in the armature coils, and the average of four observations made a record for a given angular position of the coils.

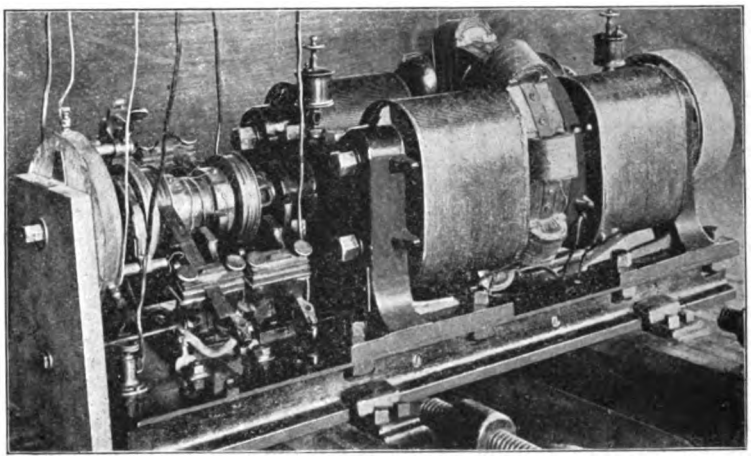

Fig. 1.

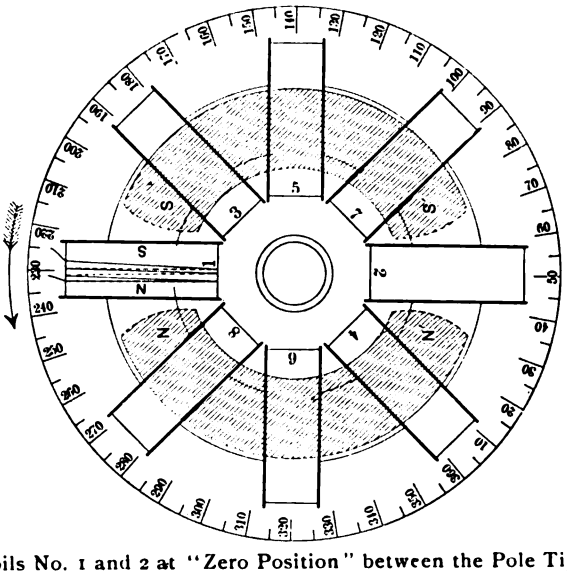

Fig. 2.—Showing Coils No. 1 and 2 at "Zero Position" between the Pole Tips N, S, and N', S'.

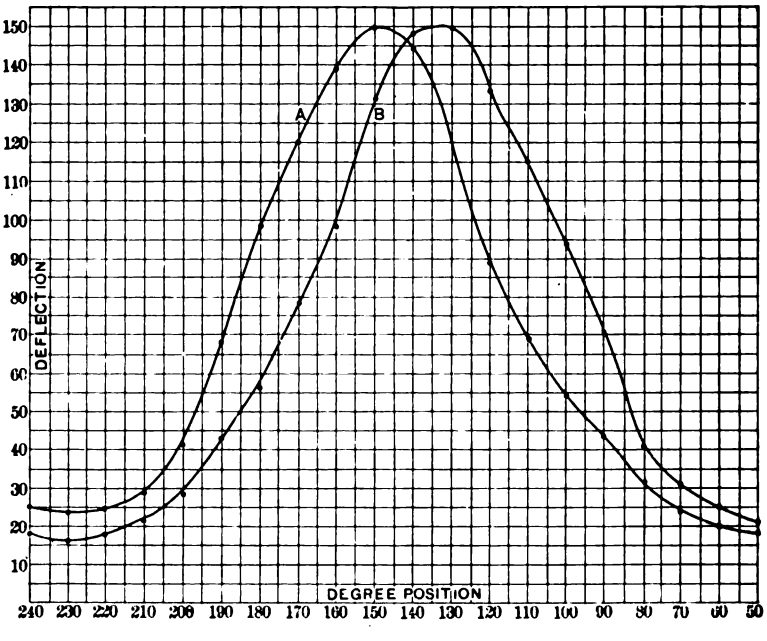

Plate 1.

The angular position of the coils relative to the poles was indicated by the graduated disk of the contact-making device by adjusting it relatively to a point on the

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coutact wheel at the time of taking each reading. Knowing the deflections of the galvanometer and having complete data covering the calibration of the instrument and the construction of the armature, the inductance of the coils at any given point was very readily calculated.

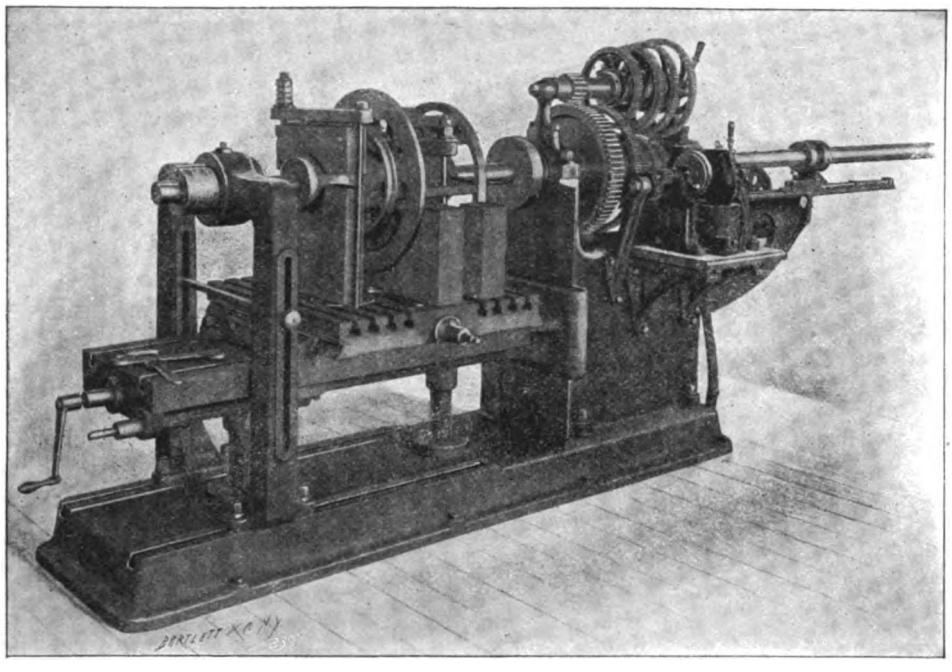
In determining the form of the electromotive force waves induced in the coils and appearing at the brushes of the machine, a form of contact-making device shown in Fig. 1 was used in connection with an improvised form of electro-dynamometer. The contact-making device possesses no new features. The galvanometer is of the Weidemann type.

The bell-shaped magnet and copper damper were removed from the instrument, and in place of these a wooden ball carrying a coil of fine wire imbedded in a deep narrow groove cut into its surface was substituted. Two pieces of copper wire were mounted upon the ball or

ARMATURE INDUCTANCE.

In determining the coefficient of self-induction of coils 1 and 2, coil 1 of the armature was placed at the 230° position, as indicated in Fig. 2, since at this point the magnetizing power of the coils was least, owing to the large magnetic reluctance of the circuit traversed by the lines of force emanating from the coils. The high reluctance is due to the fact that the iron of the core surrounded by the coils, and the iron of the pole tips N, N', and S, S', is all highly saturated by the field flux, and to the fact that the lines of force set up by the coils must either span an air-gap many times larger than the clearance space, or else pass through the entire field circuit of the machine.

When in the 230° position and with a constant current of ten amperes flowing in the field circuit, and a constant current of 4.3 amperes flowing in coils 1 and 2, the ballistic



Size 1 Motor Geared to Horizontal Boring Mill. Speed Changes by Nest of Gears. Crocker-Wheeler Electric Company.

needle in the plane of the coil, and at the extremities of a diameter to form an axis of rotation. The upper end of this axis made one terminal of the coil; it carried a small plane mirror and was connected at its extremity to a piece of hard drawn brass wire. This wire being also attached to the torsion head, both sustained the weight of the ball and balanced by its torsion the deflecting force of the current impulses passed through the needle. The lower end of the axis formed the other terminal of the coil and carried a small paddle.

It dipped into a cup containing mercury and glycerine; the glycerine sufficing to dampen the needle and the mercury making electric contact with it. When in use, the field coils of the galvanometer were excited with a constant current. The ball or needle was connected directly in series with the rotary contact, and with from two to three incandescent lamps, according to the value of voltage to be measured. The instrument was calibrated by connecting a constant current machine in series with the needle, lamps and rotary contact, and comparing the deflections of the needle taken while the contact was rotating at normal speed with the readings of a voltmeter connected to the terminals of the source of constant E. M. F.

During all the experiments the galvanometer gave deflections as constant and as dead-beat as those of a Weston ammeter. The arrangement of this apparatus is analogous to that described by Duncan* in 1892.

* Duncan, "Note on some experiments with Alternating Currents." Transactions, vol. ix., p. 79.

galvanometer gave a deflection of 25 both at the "make" and at the "break" of the current. The current in the coils at this time was flowing in the same direction as that in which the alternating current is flowing when the coils are passing out from under the pole tips, and the armature is rotating in the normal counter-clock-wise direction. From position 230° the coils were moved in a clock-wise direction, as viewed from the commutator end. This is opposite to the direction of rotation of the armature when running, but in the same direction as that in which the rotary contact brush was moved when the E. M. F. curves were taken. At the 220° position "make" and "break" readings both equal to 24 were obtained. At position 210° the readings gave 25 divisions again. At 200° they were all 30 divisions, and so on through one-half of a revolution of the armature. When plotted, these readings gave the curve A of Plate 1.

(To be continued.)

NEW TYPES OF ELECTRO-MECHANICAL DEVICES.

The system employed in modern shops of having each piece of machinery driven by a separate motor has become highly perfected and well developed by the Crocker-Wheeler Electric Company, of Ampere, N. J. The modern machine shop can and is being run in a most economical manner on this basis. It has been estimated that from twenty to forty per cent. of the power is

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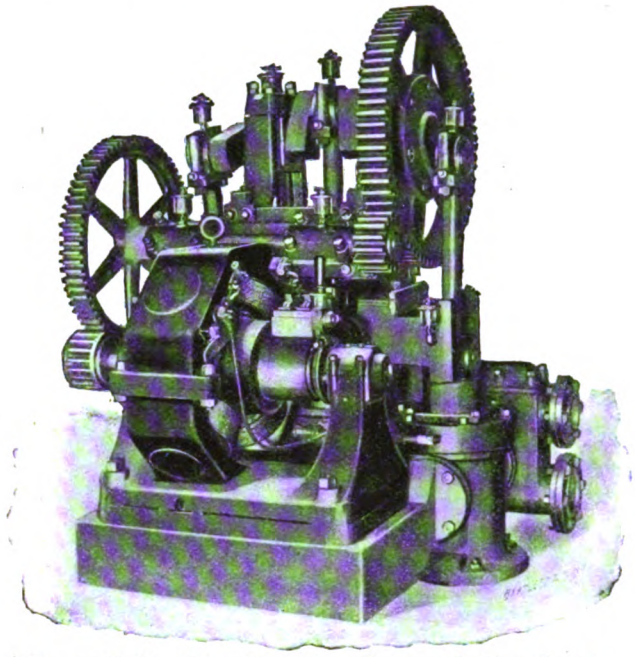
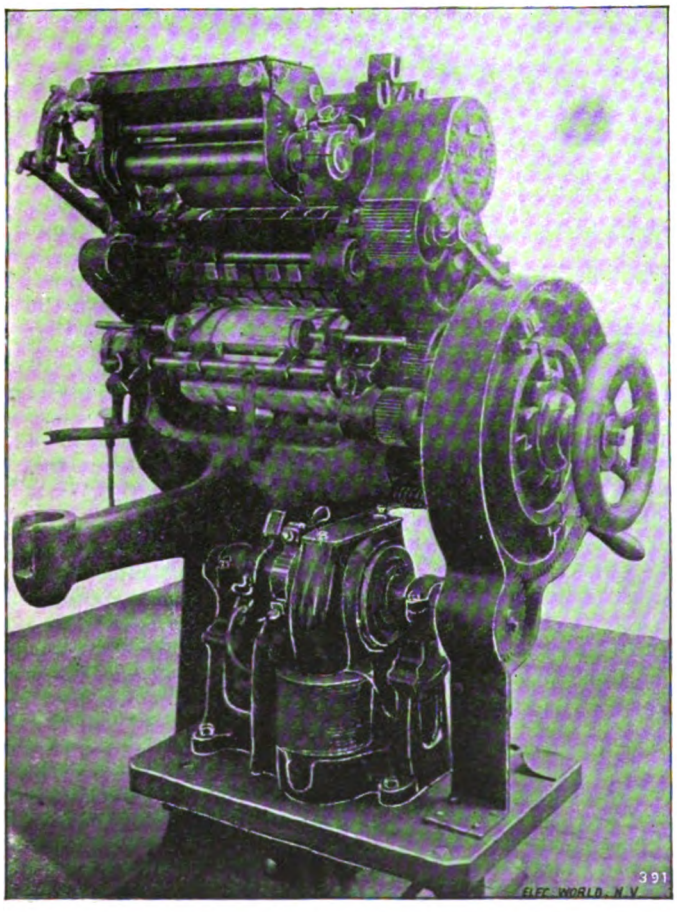
wasted in main and countershafts, which means, that without a single tool operating, many tons of coal are burnt per annum to drive an assemblage of belts and shafts which have been used simply for the purpose of distributing the power in a way which has been proven to be wasteful and unsightly. The modern method as shown by the various photographic reproductions contained in this article prevents this waste of power by having a motor control each machine, which implies no waste of power when said machine is not being used. It is necessary, of course, to consider the cost of wiring and motors with the expense of operating as against the cost of the paraphernalia of shafting and belting with its cost of power. It will be seen in the long run that the advantages accruing from an electrically driven machine shop or its equivalent from many standpoints, give ample proof of the superiority of this means of distributing power over the old-fashioned countershaft and belt method.

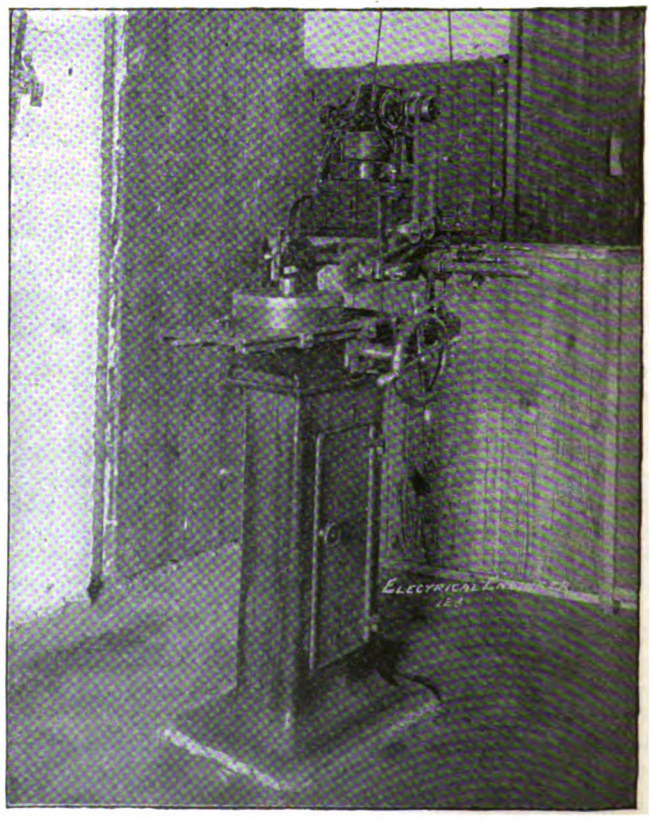


Size 25 C.-W. Motor Geared to Deming Triplex Pump



Size ½ Motor Geared to Harris Automatic Envelope Press. Crocker-Wheeler Electric Company.

It does not seem as if the general public were fully aware of the great benefits of direct-connected machinery, and it is extraordinary to realize that in many cases the manufacturers having a multitude of small machines and their own electric light plant have not investigated the



Size ¼ Motor on Electric Surface Grinder. Motor travels with the Emery Wheel. Crocker-Wheeler Electric Company.

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The Electrical Age.

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NEW YORK, MAY 21, 1898.

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THE RŒNTGEN SOCIETY.

In a recent address delivered by Prof. Silvanus Thompson before the Rœntgen Society, of London, the subject of ether waves and X-rays was discussed. In the opinion of Prof. Thompson the discovery and application of Rœntgen rays could be classed with Lister's antiseptic system and the use of anæsthetics. It seemed from the tenor of the speaker's address, that operating surgeons owe as much to Rœntgen as they do to the promulgators of the above mentioned departments of medicine. It has been found, according to Thompson, that when the X-rays fall upon an electrified body they tend to dissipate the charge, exercising an ionizing effect on its particles of matter. He classified the opinions of our eminent thinkers regarding the nature of X-rays ; speaking of the theories of Nikola Tesla and Dr. Crookes as indicating a rapid motion of material particles so disassociated that they can hardly be regarded as atoms in the ordinary sense of the word; then the opinions of those that consider X-rays a species of ether wave of a longitudinal character, and finally the speaker referred to Sir George Stokes, who believes Rœntgen rays to consist of transverse impulses. The general reader of scientific literature can very easily conclude from these remarks that no fixed opinions could possibly exist of a reliable nature in consequence of the doubtful attitude of such men as these. There are two effects produced by X-rays which can be considered from a popular standpoint. The semi-optical and the physiological. It may be that the production of X-rays brings into existence a secondary influence, casting a shadow of doubt over the real and absolute nature of the waves. The Rœntgen Society have for their object a better comprehension of the nature of these mysterious waves, and although subjects will be discussed that do not relate entirely to Rœentgen rays, the endeavor of this scientific body will be the displacement of the term "X-rays" by one having a more definite meaning.

THE OPEN CONDUIT ROAD.

The increasing popularity of the open conduit road indicates a change of opinion among engineers of a highly beneficial character. The open conduit road was a failure some eight years ago at the start, not only in New York City but in European towns. During the course of fifteen years' careful experimenting sufficient experience was gained to show experts that the open conduit road must be built as strongly as the substructure of a cable road. In addition they quickly realized the importance of an ever present means of drainage. With a road constructed so as to provide both drainage and solidity, the question of insulation became an incidental one. In the original Lenox Avenue road conductors were used composed of brass pipes through which steam was to have been sent in case ice accumulated around them during the cold spells. Subsequently, in the new Madison and Second avenue roads the current-carrying conductor was shaped like a T-rail insulated at intervals and bolted into position. The public are well satisfied with this system of transit; the municipal authorities believe it has come to stay and will eventually replace the cable systems at present in vogue in certain large cities in the United States. The day an automatic block system is laid, of any considerable length, will be one noted in the annals of electrical engineering as the first practical outcome of a long series of costly experiments. No less an authority than Silvanus P. Thompson believes in the future of automatic electric roads, and those undertaking improvements in this direction will if successful in their efforts meet with universal commendation. The open conduit road, however, is a pronounced success from a practical engineering standpoint.

THE ELECTRICAL EXHIBITION.

At the Electrical Exbibition held in Madison Square Garden the genius of Edison shines forth as brightly as ever. On the sidewalk outside the building, at the entrance, and within the hallway may be found huge boulders of iron-bearing rock, each weighing many tons. A working model showing the process through which this rock is put shows the remarkable simplicity of the apparatus and means by which the iron is separated from the sand after the crushing process is completed. Thomas A. Edison may become a second Carnegie, although his name, present life and past history more than compare with that of the multi-millionaire, who like himself is self-made and individualized. A great deal at the Electrical Exhibition has been moulded into shape by the hand of Edison, and we are glad to see his son also in the field of commercial activity fighting for prominence and reputation. More than two hundred and fifty thousand men are laboring at the inventions of Thomas A. Edison through the medium of different corporations, for the magic power of this man's touch has awakened into being tremendous enterprises that add year by year to the world's quota of prosperity.

Montreal, Que.—Mr. J. A. Corriveau states that the Montreal and South Shore Railway will be proceeded with early in the spring.

Hamilton, Ont.—The Hamilton Radial Railway Co. have, it is said, abandoned the idea of the extending of the road beyond Burlington.

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advantages of this system. It is highly probable that more than a million dollars is annually wasted in driving heavy belts and long lines of shafting in the factories of this country, though the supplanting of this heavy machinery by wires would certainly save a large percentage of this sum.

The Crocker-Wheeler Electric Company thoroughly believe in the universal use in the near future of direct connected machines, and have been making every effort to introduce their system in all the large manufacturing establishments in the United States. Their belief is so absolute that they have begun by following out this practice in their own works at Ampere, N. J., where every machine is individually operated by electricity.

such an enviable reputation. Here will be seen the most complete exhibit of panel and feeder boards heretofore attempted, all of the very latest forms as well as the older and better-known types being shown mounted on marble and slates in innumerable variety.

In the rear of the booth all types of the well-known Zimdars & Hunt automatic switches and motor starters are shown. These devices are now so well and favorably known that it might be expected that they would have no special interest here for the technical observer; but in this we would be mistaken, for there are here to be seen many new types recently brought out, and which contain many new features of merit. A new type of automatic motor starter, known as type D, is here shown for the first time,

Unique Exhibit of Zimdars & Hunt.

MADISON SQUARE GARDEN.

EVERY VISITOR to the Exhibition, particularly the exhibitors themselves, noticed the rapid increase in attendance each successive night. The Electrical Show represents in detail the best ever given in the East and compares favorably with the great Chicago exposition, which may have exceeded this in the magnitude of its display, but could not equal it in the varied nature of its novel exhibits.

THE EXHIBIT OF ZIMDARS & HUNT has called forth much favorable comment from visitors to the Exhibition. Situated on the 26th street side, not far from the main entrance, it is one of the first exhibits met with by the visitor in his tour, and the glittering array of bright copper objects attracts his eye before he has come up with the booth. Upon closer observation these objects are seen to be a display of the panel boards, switches, automatic motor starters, etc., which have given this firm and so well has it been received that the firm has already received many orders for them in their various sizes.

One wall of the booth is almost entirely taken up with a display of knife switches, lugs, connections, etc. These will well repay a close examination, as the closer they are examined the more clearly will their many valuable features be brought out. All types are shown and in the various sizes. The copper-back connection which this firm has recently introduced also comes in for considerable attention here.

The instrument switches should be examined by those not already familiar with them. These, though but recently introduced, have so many points of superiority clearly evident that they immediately sprang into the favor of engineers and contractors, and one now looks for them on the latest and most up-to-date switchboards.

In addition to the above, there are many other devices or real merit on exhibition here which the visitor will do well to look up.

The booth is enclosed at the front by copper bars representing switchboard bus bar work, a gigantic knife switch serving for a gate. As might be expected, this novel feature is not overlooked.

THE SPRAGUE ELECTRIC COMPANY are meeting with considerable success in placing their Lundell Horseless Carriage Motor on the market. Quite a number are in use in this country, and very many abroad, particularly in England. In London, the Lundell Motor Equipment has recently been placed upon the mail-van service, and excellent results are reported. Since the vans have been so equipped, it is stated that none has ever been behind time—a record which no other vehicle ever succeeded in obtaining.

THE SPRAGUE ELECTRIC COMPANY announce

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that the advance sales for their Lundell Fan Motors are greater than in any previous season. Doubtless, their handsome new catalogue will serve to increase orders, as a great variety of handsome designs is therein displayed to great advantage.

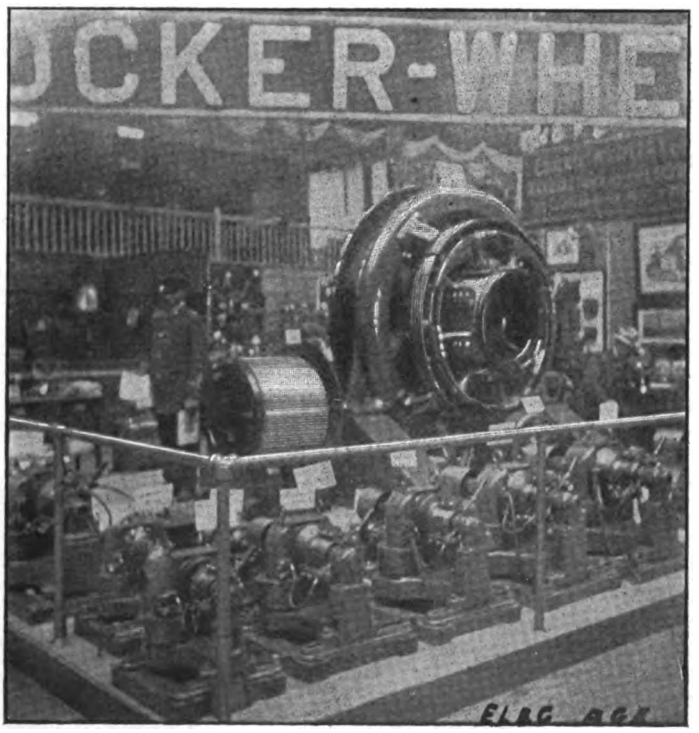
THE STEAM PIPES at the Electric Show are one of the features of the great power plant in the basement. Throughout the basement, connecting all the various automatic engines, are to be seen numerous white pipes; these are the steam pipes, and are covered with the

Garvin Machine Company and Peru Electric Mfg. Co.

M'CARTHY BROTHERS & FORD have been appointed agents for the Sprague Electric Company for Buffalo, N. Y. The headquarters of the house are in the fine new Caxton Building in that city. Other appointed agents are Morton, Reed & Company for Baltimore, Md., Walker & Kepler for Philadelphia, and Pettingell-Andrews Company for Boston.

popular Nonpareil Cork Steam Pipe Covering made by the Nonpareil Cork M'f'g Co., of the Gerken Building, West Broadway and Chambers street, N. Y. This is said to be the best non-conductor of heat extant. Write for circular of references.

ONE OF THE MOST INTERESTING FEATURES OF THE ELECTRICAL SHOW is the booth of the



Crocker-Wheeler Electric Company.

A VERY POPULAR EXHIBIT is that shown by Elmer P. Morris, a name so well known among the trade that further remarks are unnecessary. All kinds of electrical apparatus for light, power, and transmission, as well as railroad work, are there for inspection. Mr. Morris carries a great trade and bears a most excellent reputation as a conservative and reliable business man.

International Correspondence Schools of Scranton, Pa., whose New York Enrolment office is located at 14 East Seventeenth street. No better proof of the popularity of the methods of instruction employed by this institution could be shown than to watch some of their old students taking their friends away from the spectacular end to have them talked to by representatives of the

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schools. The large number of friends they have around them is accounted for by the fact that they have now over 45,000 graduates and students throughout the world. The booth of the Scranton Schools is very attractive. A picture of the school buildings 5 x 7 feet in size, surrounded by electric lights, showing the picture off to great advantage, hangs at the back of the booth. All the engineers and electricians attending the Exhibition who desire to obtain a technical education in engineering or electricity will find it to their advantage to visit this booth.

NEW YORK NOTES.

MR. SAMUEL INSULL, president of the National Electric Light Association and of the Association of Edison Illuminating Companies, was in New York last week. He takes a very lively interest in the progress of the exhibition, and has informed the management that he will take the utmost pleasure in coming on specially from Chicago, in behalf of those two representative bodies, to participate in the opening exercises on May 2nd. These exercises as now arranged promise to be of an unusually striking and interesting character.

MR. REYNOLDS, the steward of the old Electric Club, is managing the Manhattan Hotel and Restaurant, 1281 Broadway. It has been refitted and was opened April 18th. Messrs. Holloway & Irish are putting in the electric plant, dynamos, electric fans, lights, etc.

CHAS. L. WARRICH, arc and incandescent lamps, electrical supplies and lamp material, is now at 76 Morris avenue, Newark, N. J.. office of the Essex Incandescent Lamp Co.

ELECTRIC MOTORS AND THEIR APPLICATIONS.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

If a motor be considered as a machine in which electrical energy is converted into mechanical energy, its convenience and usefulness cannot be misunderstood. There is at present no device of higher efficiency. Its rating is of the highest order and its universal application a matter dependent entirely upon the cost of electricity. There are many types of motors and dynamos on the market, whose features may be critically examined. The general classification of the windings and a division of the magnetic circuits into groups is most instructive to the reader.

Windings.—The dynamo and motor are both made up of two distinctive parts,

Armature,
Field.

Each of these has a distinct function to perform. The armature, by rotation or otherwise, cuts the lines of force and thus creates within its turns an electrical pressure called electromotive force.

In the great majority of dynamos and motors the armature revolves, and thus performs the work it was intended for.

The field is of a different construction from the armature in this respect, that it simply supplies magnetism to the armature. The greater the strength of this magnetic field, the higher the speed of the armature, and the greater the number of turns on the armature, the higher will be the electromotive force (E. M. F.) produced.

The field merits our first attention; it is generally wound in three ways:

Series,
Shunt,
Compound.

Series Winding.—The series winding is one in which the entire current from the armature flows around the magnet winding, both being connected in series in order to obtain this result. Also, if used as a dynamo, the current which issues from the armature passes through lamps, etc., before it reaches the field.

Therefore, we have a complete series circuit, from armature through outside circuit, through field back again to armature. Arc light machines are series wound and in the Thomson-Houston, Brush, Excelsior and Wood dynamos this winding is characteristic.

Shunt winding.—This type of winding, as its name implies, is in shunt or multiple with the terminals of the dynamo. The field magnets are wound with a size of wire whose resistance prevents it from taking more than enough current to provide the magnetic field required. The current from the armature splits up into two parts. One portion, which is the greatest, supplies the outside lines with current. The other portion is taken away by the magnet winding. The amount required for this purpose varies in dynamos of different sizes from forty per cent. to two per cent.

Nearly all continuous current incandescent light machines are shunt wound; such types as the Edison or General Electric dynamo, the Eddy, Walker, Card, etc. This reference applies only to the magnet, or, as it is generally called, the field winding. The majority of continuous current motors are shunt wound.

Compound Winding.—To obviate certain difficulties in incandescent lighting, such as armature reaction, loss of pressure in the armature and loss of pressure in the lines, a winding partaking of the nature of both series and shunt, called compound winding, has been adopted. Its inventor, Brush, was the founder of a great arc light system. In a dynamo the field winding may be to a certain extent neutralized, due to the fact that the armature in carrying current also acts as an electromagnet.

It sends its magnetic lines oppositely to those produced in the field, and thus reduces the effective or resultant field more and more with each increase of current.

The current proceeding from the armature is made to regulate the machine in a very ingenious manner. The coil effects just described may be compensated for by a device which will strengthen the field to the same extent that the armature tends to reduce it; and it may be further strengthened so that the volts lost in the armature and line will be generated in addition, as needed. To effect this result the ordinary shunt winding is first applied; then a series winding is placed beside or on top of this. The series winding has passing through it the entire current of the machine, practically speaking. If this increases when more lamps are applied to the dynamo, the current in the series coil increases; that is to say, its magnetomotive force or ampere-turns increases. If the magnetism supplied by these ampere-turns exactly equals that which the armature neutralizes, the machine is compounded for armature reaction. If it supplies sufficient extra magnetism to make up for that lost in the armature and line besides, it is entirely compounded and the dynamo will act automatically with all loads. The drop in the armature, it must be observed, is measured by the product of the current and resistance.

Current × resistance = drop.

If the armature has Resistance = .1 ohm,
Current = 100 amperes.
Lost volts in armature = .1 × 100 = 10 volts.

These calculations apply likewise to the line. If the line resistance = .002 ohms,
and current = 100 amperes.
Lost volts in line = .002 × 100 = 2 volts.

The field may be cut down by armature reaction 10

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per cent. when the armature is carrying 100 amperes; if 110 volts are to be generated, there would be a total loss as follows:

Due to armature reaction, 11 volts,
" " drop, 10 "
" line " 2 "
—
Total, 23 volts.

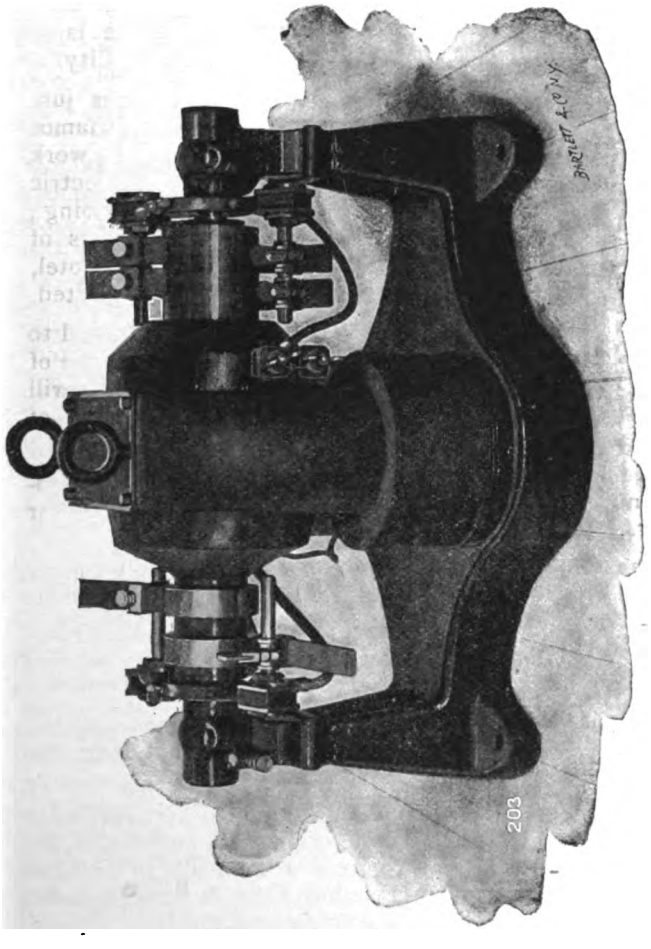
As a rough estimate the compound winding would be called upon to compensate for this loss, which, as noted above, equals 23 volts.

Types of dynamos.—The shapes of dynamos and motors are classified under two general headings. The number of magnetic circuits determine this:

Single magnetic circuits,
Multiple " "

These may be expressed by the names:

Bipolar or two-poled dynamos,
Multipolar or many-poled dynamos.



Dynamotor, Low Voltage and Low Frequency, Alternating Secondary.

Multipolar dynamos have poles in pairs, in multiples of two. They are being extensively used at present in all large stations and in many large isolated plants. The arrangement of the poles to complete the magnetic circuit gives rise to many curious shapes.

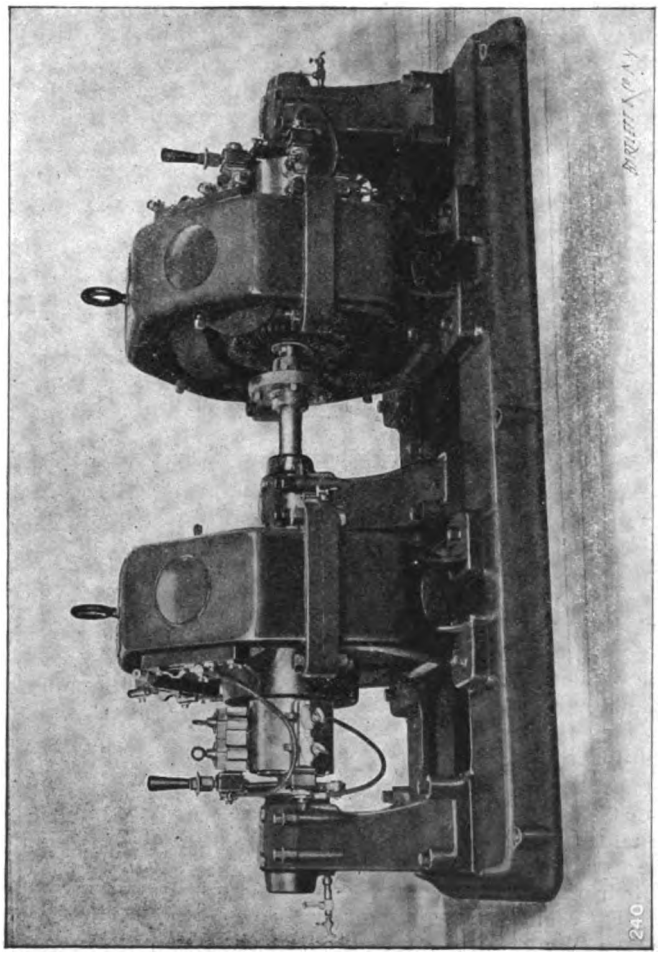
The ironclad dynamo, with its poles entirely inside, the ordinary horseshoe pattern resting on its keeper or on its poles, and the consequent pole types, in which two magnetic circuits feed into one pole, are very interesting to the student. Whilst it is a matter of opinion in many cases as to which is the best, they must be examined from a mechanical as well as an electrical standpoint to appreciate the benefits of each.

When a motor is to be installed certain precautions must be observed in order that no injury from fire can result and no danger from shock exist.

The fire underwriters of every large city impose limitations upon contractors and prevent them from doing careless work. It is usual to mount the motor upon a fireproof foundation and have a large pan underneath to catch the oil drippings. A zinc pan is frequently used for this purpose, the motor being mounted in the centre of it. The starting box must be of slate, and have under it a large sheet of asbestos paper. The fuse blocks, devices used for the protection of a line, must be covered to eradicate the dangers of fire from the vaporized metal.

In total the installation of either motor or dynamo must be based upon the fact that the risks from shock and fire are to be entirely removed. A low voltage motor or dynamo does not introduce much danger from mere shock; in this respect, up to about 400 volts the person in charge is secure, but the chances of fire always exist.

A loose hanging connection, a short circuit on the line, a bad ground, etc., may bring about this danger unless regular tests are made to keep the line clear aud dynamo insulated. A lightning arrester is a very necessary adjunct to a plant having an outside line. Frequently a station is destroyed by lightning, according to report. This may not be true, although lightning is in many cases



Latest Application of Motors. Size 40 Motor-Dynamo "Booster" Motor end, C.-W. E. Co.

the original cause. Lightning by striking a line, or dynamo through the line, usually sparks across every available gap.

An arc is thus started and continued by the generator itself. It is thus very likely that in many instances the burning is done by the dynamo current, although the original cause—lightning—has long since disappeared. Protectors in many cases fail to protect because there is a certain element in lightning arresters that must be improved, and a peculiar oscillatory nature to the discharge that must be better understood in its many variations before they can be used with certainty in every case.

Both dynamo and motor are protected from an overflow of current by means of a safety fuse, cut-out or automatic circuit-breaker. The cut-out is simply a piece of lead wire inserted in the circuit and of such a size that a flow exceeding the regular amount will melt it and open the line. The danger being over it is then replaced by another piece. Good insulation to either dynamo and motor, good safety devices, in the shape of either cut-

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outs or lightning arresters, and a drip-pan to catch the oil, comprise the essential elements of a good installation.

QUESTIONS FOR REVIEW.

(1) What are the important parts of a dynamo or motor?

(2) How many kinds of winding are employed in the field?

(3) In what manner is the series coil effective in producing regulation?

(4) Name the types of magnetic circuits.

(5) What means are taken to obviate fire and shock in installing motors?

INSULATION AND CONDUCTION.

(Continued from Page 269.)

Silk should never be used where high insulation is required, as pure cellulose dry and boiled in paraffin is so much superior to it that there is no comparison. With pure cellulose, coils with only 1700 feet of wire per inch of spark stand perfectly, *i. e.*, the spark may be five times longer than the coil. In ordinary use, coils having a a spark length 3⅓ times that of the coil have been run for long periods with no break-downs.

As regards oil insulation for ordinary induction coils, the writer has not had sufficient practical experience. I believe, however, that very good results are obtained. With regard to the Thomson high-frequency coil,* there is no question of the efficacy of oil there, especially with regard to ease of repair. As is well known, however, the oil and coil should always be heated above 110° C. for some time if the best results are to be obtained. A very curious increase of insulating power for high frequencies in oil has been noted by Elihu Thomson, who has suggested that it might be due to inertia of the molecules of oil. To test this, one of the writer's students, Mr. Bennet, constructed a two-phase high-frequency electrostatic field. Though insulators placed in this rotated even when placed within a $\frac{1}{16}$ inch glass flask, the effect was found to be due to air currents, and when these were eliminated no movement was obtained, so that the cause of this effect is still unknown, and it is doubtful if true dielectric hysteresis has ever been observed.

So far as Mr. Chattock's experiments and the experience of the writer go, there is not a great deal of difference between the dielectric strength of different substances. It is probably related to the tensile strength. As mentioned previously, the writer† pointed out that there was strong evidence to show that the tensile strength of a substance was due to the mutual attraction of charges on the atoms, and that the observed values agreed well with the calculated and followed the same law. Some time later Chattock‡ in a very interesting and able paper showed that, as the results of his experiments, the dielectric broke down when the slope of potential was great enough to pull apart atoms having charges of the same dimensions as the ionic charges. This was shown for gases, fluids and solids, and forms a very interesting —and, I believe, independent- corroboration of the writer's electrostatic theory of cohesion. Consequently, the nearer the atoms are together and the greater their rigidity, the greater also their dielectric strength.

Chattock's experiments give for solids and fluids—

SUBSTANCE	VOLTS PER CM. FOR BREAKING DOWN.
Glass	919,000
Water	1,050,000
Oil	930,000

which agrees well with the theory.

From the above it will be seen that if the materials are pure, the ohmic resistance is of not much importance, a compound having its molecules held together tightly will have a good dielectric strength for D. C. voltages.

(To be Continued.)

NEW YORK ELECTRICAL SOCIETY.

The second lecture of the Society's Exhibition series was given in the Concert Hall, Madison Square Garden, on Thursday, the 19th, at 8:30 p. m, by Professor I. Fujioka, of the Imperial University, Tokyo, Japan, on: "Electricity in Tokyo and the Kingdom of Japan."

INDIA RUBBER AND GUTTA PERCHA INSULATING Co., J. W. Godfrey, New York manager, assisted by F. W. Harrington and J. B. Olsen, are exhibiting a full line of rubber and gutta percha covered wires for all carrying capacities; also a full line of submarine and ærial cables. The samples represent cables and wires in actual use and have not been made specially for this exhibit. It has been intimated that these samples were made abroad, as it is said there is no factory in this country with facilities for producing the same. We note particularly the 3-conductor concentric cable, each conductor of 1,000,000 C. M. capacity. This cable is in use in the Power Transmission plant of Salt Lake City.

J. E. FULLER, 22 Spruce street, New York, has just opened a fine electric jobbing and repair shop. Dynamos installed and kept in repair; millwright and machine work done at short notice. All at reasonable rates. Electric lights installed; motors and fans put up and kept going; call-bells for offices and residences; burglar alarms of every description; gas lighting and apparatus; hotel, house and office annunciators. Suburban orders solicited.

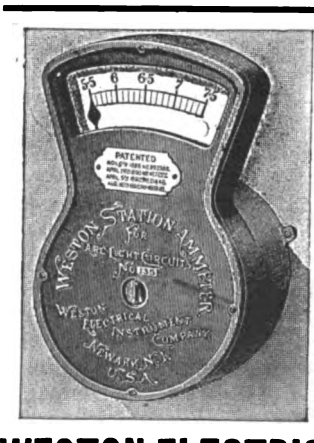
The business of A. L. Bogart Co. has been removed to 123 Liberty street in order to be nearer to the centre of the electrical trade. The offices at 50 E. 20th street will continue open until the first of June for the reception of orders, etc.

Kingston, Ont.—The Kingston & Smith's railway promoters will, it is said, seek for a new charter with power to build an electric road between this city and Ottawa.

Berlin, Ont.—The Galt and Preston electric railway will likely be extended to this town.

Victoria, B. C.—The Mountain Tramway and Electric Company will seek incorporation by private bill at the approaching session of the legislature.

Bobcaygeon, Ont.—A meeting was held here last week to discuss the electric railway project. A committee was appointed to take steps to form a company to build an electric road connecting Fenelon Falls, Bobcaygeon and Peterboro. W. J. Reed is acting secretary.



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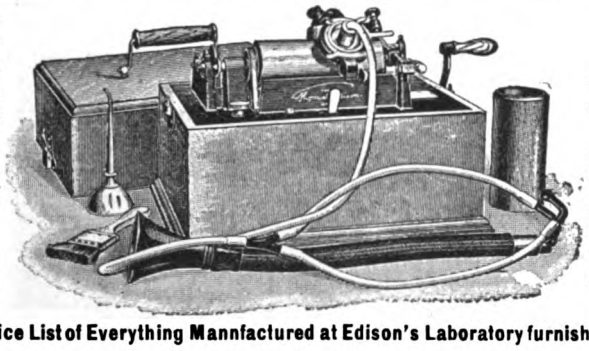

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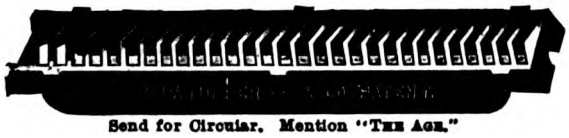

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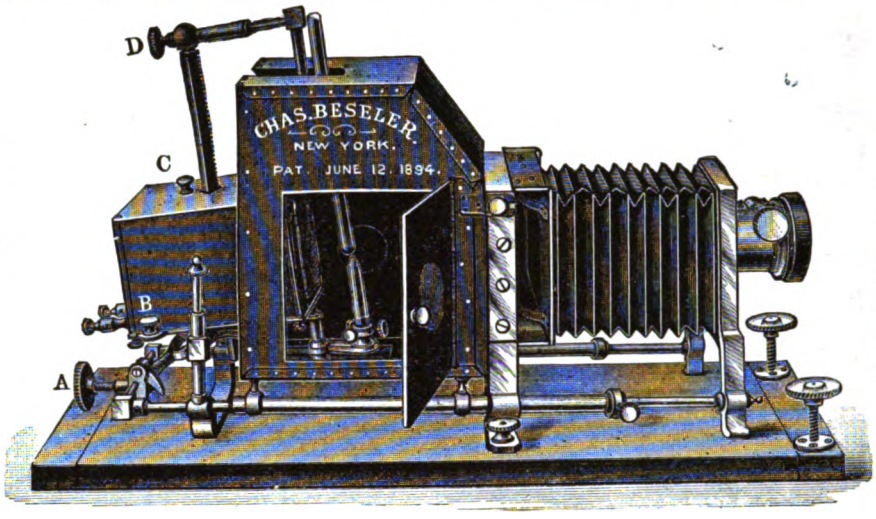

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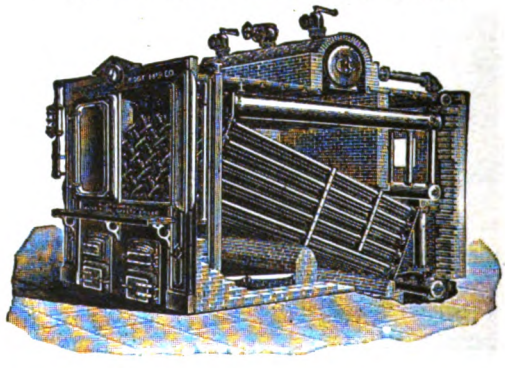

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The Electrical Age.

VOL. XXI—NO. 22 NEW YORK, MAY 28, 1898 WHOLE NO. 576

Mr. Marcus Nathan, Manager of the Electrical Exhibition.

THE GROWTH OF ELECTRICAL ENTERPRISE.

The influence of an enterprising spirit upon those engaged in an established industry is doubly beneficial to the general public. The electrical fraternity have, through the efforts of Mr. Marcus Nathan, been taught to regard an electrical exhibition as an excellent opportunity for them to compare notes in a practical manner, increase their business and meet the great masses, direct contact with whom is only occasional. The public are, after all, the best judges of progress and are keenly alive to the benefits derived from an electrical exposition. It is absolutely necessary for them to have one each year, as the advances made in this wonderful field of science are sudden and startling.

Mr. Marcus Nathan, the manager of the Electrical Show at Madison Square Garden, also of the last that occurred in New York City, at the Grand Central Palace, is peculiarly in touch with our electrical friends as well as the eager and curious public. This clairvoyance with both enabled him to select features of interest for the show which will remain in the memory of visitors for a long time.

Artificial daylight, wireless telegraphy, X-rays, electric heating and cooking, welding, and a great variety of other things too numerous to mention holds the attention of visitors night after night. It may be that five years years hence these advances will have become prosaic, but the public owe their knowledge of them to-day to the enteprise and skill of Mr. Marcus Nathan, whose management of the exhibition and arrangement of exhibits deserves the highest credit.

The immense amount of labor involved in the care and growth of this enterprise can only be fully appreciated by those connected with the exhibition during its inception and progress. The limited time at Mr. Nathan's disposal for the full development of the show led many to wonder whether it would be ready the opening night. Mr. Nathan's persistence and resolution overcame all obstacles, however, which included strikes, etc., and showed what well directed efforts can do in the face of many opposing circumstances. Judging from the success of the 1896 and 1898 exhibitions we firmly believe that the next will far surpass them in turn.

As a fixed institution an annual electrical exposition would add to the advantages of an educational and instructive nature offered in this city, and become in the course of time famous throughout the United States and possibly the civilized world.

SLOW-SPEED MOTORS.

In redesigning its line of motors to run at slow and moderate speeds, the General Electric Company has adopted valuable improvements, which experience with motors of former types and careful observation of their operation under actual commercial working conditions have proved advisable. The motors of the present type are for their output, perhaps, the lightest and most compact built.

For all powers up to and including 5 H. P. in the slow speed and 8 H. P. in the moderate speed, the motors are bipolar; in larger motors, up to and including 95 H. P., four-pole construction is used. The latter method of construction has been adopted for large and moderate-sized motors on account of its many manifest advantages, viz.: shorter magnetic circuits, with consequent reduced exciting current; greater output and higher efficiency for given weight and speed; economical distribution of magnetic material and minimum of floor space. While in motors of a given design reduction of speed necessitates increase of weight, if the same output and excellence of construction is obtained, the four-pole design of the General Electric Company effects such economy of material that the output is extremely large, compared with the size and weight of the machine.

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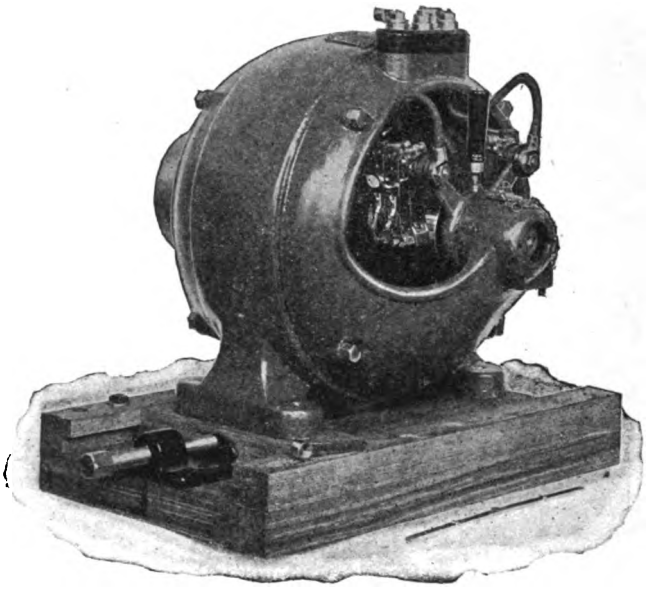
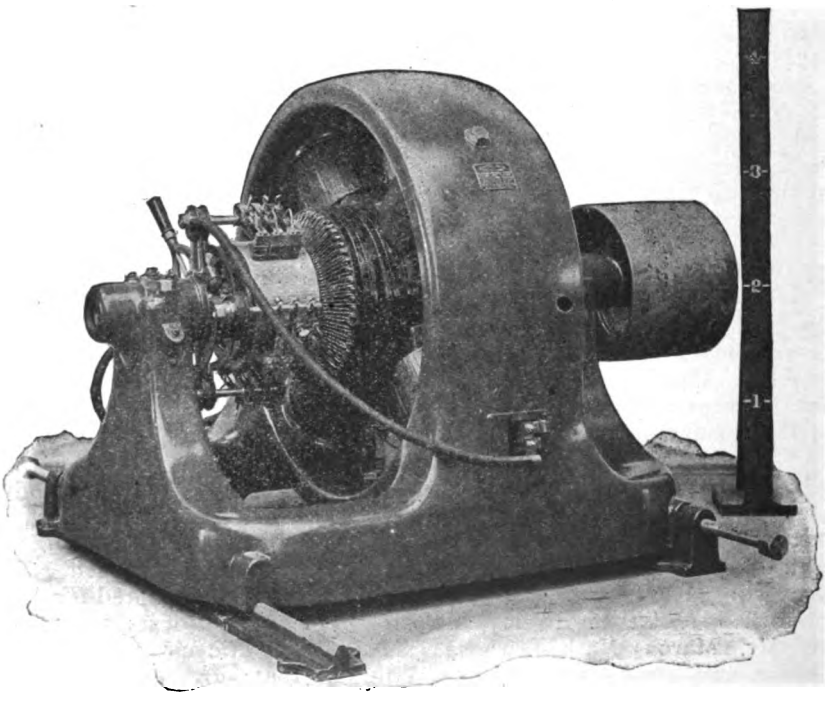
The frames are of iron of the highest quality and the pole pieces of special, soft steel. As the pole pieces are readily removable, the field coils may be taken off and changed without disturbing either the frame or armature. The frame is divided horizontally, and the upper part may be easily lifted off to gain access to the armature. The pillow blocks of the four-pole machines are cast with the bed plate and the lower part of the machine, thus ensuring perfect centring of the armature. The bearings are all self-aligning, self-oiling and of ample size. The core is built up of laminations slotted to receive the armature coils, which, lying below the outer surface of the core, are protected from mechanical strain and abrasion. The spider carrying the core is prolonged at each end in two flanges, upon which the ends of the coils lie without being bent. The armature is wound with the well-known G. E. barrel winding, which provides a large radiating surface for armature conductors and reduces the length of wire to a minimum, thus reducing armature resistance losses and increasing the efficiency of the motor. The coils may be readily removed and replaced, and, being embedded in the slots, can neither move relatively to the core nor vibrate. When the armature turns, air is drawn into the ventilating ducts provided in the core and to circulate throughout the entire armature structure and reduce its temperature. The exceptionally low running temperature of these motors is obtained by designing every part so as to reduce losses to a minimum and providing a complete system of air circulation. The coils are made on forms and separately tested before assembling on the core. The insulation is the same as that used in the G. E. railway motors and vari-



G. E. Slow Speed Motors.



G. E. Slow Speed Motors.

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ous tests have shown that it is tough, impervious to moisture, and practically indestructible, even under heavy overloads, or by lightning. The commutator segments are of hard-drawn copper, supported on a separate spider, and the connections between them and the armature coils are carefully made to prevent the possibility of open circuiting.

The brush holders have a solid casting connecting the brush box with the stud and an adjustable pressure spring, giving an even pressure and firm and accurate contact of the carbon brushes and the commutator—an important factor in securing sparkless and noiseless operation. A flexible conductor permanently attached to the brush connects it with the brush holder and allows of free movement of the brush in the holder, while avoiding any resistance from imperfect connection. Change from no load to overload can be made without changing the position of the brushes and without sparking. The only wear on the commutator is the friction of the brushes, which is practically negligible.

In the bi-polar machines the projecting field effectually protects the spools and armature from injury. Stability is secured in these machines by so designing the heavy parts as to bring the centre of gravity very low. All parts of both the four-pole and bipolar motors are accurately made to gauge, and are thus interchangeable. The substitution of new parts requires no special skill and can readily be made by the man in charge of the machine. On account of the slow speeds of the four-pole motors they may be belted directly to ordinary slow speed line shafting without intermediate counter-shafting. They are therefore especially adapted to all factory, mill and shop requirements. The bipolar type is adapted to the driving of lathes, printing presses, fans, drills, pumps, and indeed, to almost any work where small units of power are required and little space is available. They are arranged to run in any position, whether suspended from the ceiling, attached to a wall, or set upon the floor.

THE DEVELOPMENT OF ELECTRICAL SCIENCE.

(Continued from page 283.)

Magneto-electric and dynamo-electric generators and motors have now become so common that we are apt to forget that their introduction on an extensive scale has only taken a few years. Faraday's disk dynamo was, as has already been stated, produced in 1831, and a machine for generating electricity was made by Pixii in the following year. Pixii's machine consisted of a horseshoe permanent magnet which was rotated in such a way that its poles passed alternately in front of the poles of a similar electro-magnet. An alternating current was thus induced in the circuit which included the coils of the electro-magnet.

This machine was improved by Clarke, who removed the coils and put a commutator on the axis. Other machines were made or suggested by various physicists, and an important observation which has since been frequently overlooked, was made at this time by Jacobi, who pointed out the importance of making the cores of the coils short. Sturgeon, in 1835, made a dynamo with a shuttle-shaped armature; a similar form has long been identified with the name of Siemens. Woolrich made a multipolar magneto machine in 1841 for electroplating, and Wheatstone about this time produced his small multipolar magneto, long used for telegraph purposes. In 1845 Wheatstone and Cooke patented the use of electro-magnets in place of the permanent magnets, and Brett suggested, in 1848, that the current from the machine might be made to pass round a coil surrouding the magnet and thus increase its strength. A similar suggestion was independently made in 1851 by Sinsteden. In 1849 Pulvermacher proposed the use of thin laminæ of iron for the cores of the magnet, a proposition which has since, but probably for a different reason, been almost universally adopted. Sinsteden used iron-wire cores and made a number of experiments on the effect of varying the pole face. About this time another class of machines was proposed by Ritchie, Page and Dujardin. In these machines both the magnets and the coils were to be stationary, but the magnetism was to be varied by revolving soft iron pieces in front of the poles. Modern representatives of these machines are to be found in the dynamos of Kingdon, Stanley and others. All the machines up to this time had been of very small dimensions. In 1849 Nollet began the construction of an alternating machine on a larger scale, but died before it was completed. Machines of Nollett's type were afterwards made by Holmes and by the Compagnie l'Alliance of Paris, the latter being called the Alliance machine. These machines were used for lighthouse purposes. Holmes's earlier machines were continuous current, but later he left out the commutator, and still later again introduced it on part of the coils for the purpose of obtaining current to excite his field magnets. This latter plan was introduced after the self-exciting principle had been introduced by Siemens and Wheatstone.

A remarkable machine historically was patented in 1848 by Hjorth. In this machine a combination of the permanent and electro-magnet was used, the first to give magnetism enough to produce a current with which to excite the other. A similar idea was developed fifteen years ago by Wilde with the difference that the permanent magnet part was a separate machine. The idea of using part of the current from the armature to excite or partially excite the field magnets was at this time in the minds of a number of workers, and some remarkable machines were patented by the brothers Varly, one of which containing both a shunt and a series winding has been held by some to anticipate the compound winding now in use. In 1867 it seems to have occurred independently to Wheatstone and E. Werner Siemens that the permanent magnet part of the Hjorth and Wilde machines might be dispensed with, the resident magnetism being used to start the action. Siemens gave the name dynamo-electric machine to this type and it has stuck. In order to diminish the fluctuations in the strength of the current during one revolution of the armature Pacinotti devised his multigrooved armature in 1864. This machine did not receive the notice it deserved for a number of years, and in the meantime Gramme produced his smooth ring armature in 1870. Gramme's machine was soon recognized as being of great merit, and its gradual introduction gave rise to increased activity. In 1873 the Hefner-Alteneck improvements on the Siemens armature were introduced and in the remaining 70's quite a number of forms of dynamo were invented, the Loutin type introduced in 1875 with improvement in subsequent years being one of the best. The early 80's saw tremendous activity; the patent offices in Europe and America were flooded with inventions of various types of dynamos and motors, of lamps for electric lighting and so forth. It is curious how few of those machines have stood the test of time and how well the old types of Pacinotti, Gramme, Siemens-Alteneck and Loutin in some one of their modifications hold the field. Great progress has been made in the last fifteen years. Machines have assumed enormous proportions and the number of branches of industry to which they have been applied is now very large. Much has been learned during this time, particularly with regard to alternating currents and their application to the transmission of power, the introduction of multiphase systems being of considerable importance in this connection. In the direction of high potential and great frequency the work of E. Thomson and Tesla is of great interest.

Of the application of electricity to the production of light and heat little need be said in this connection.

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The difficulties to be overcome were largely mechanical, and with the progress made we are all familiar.

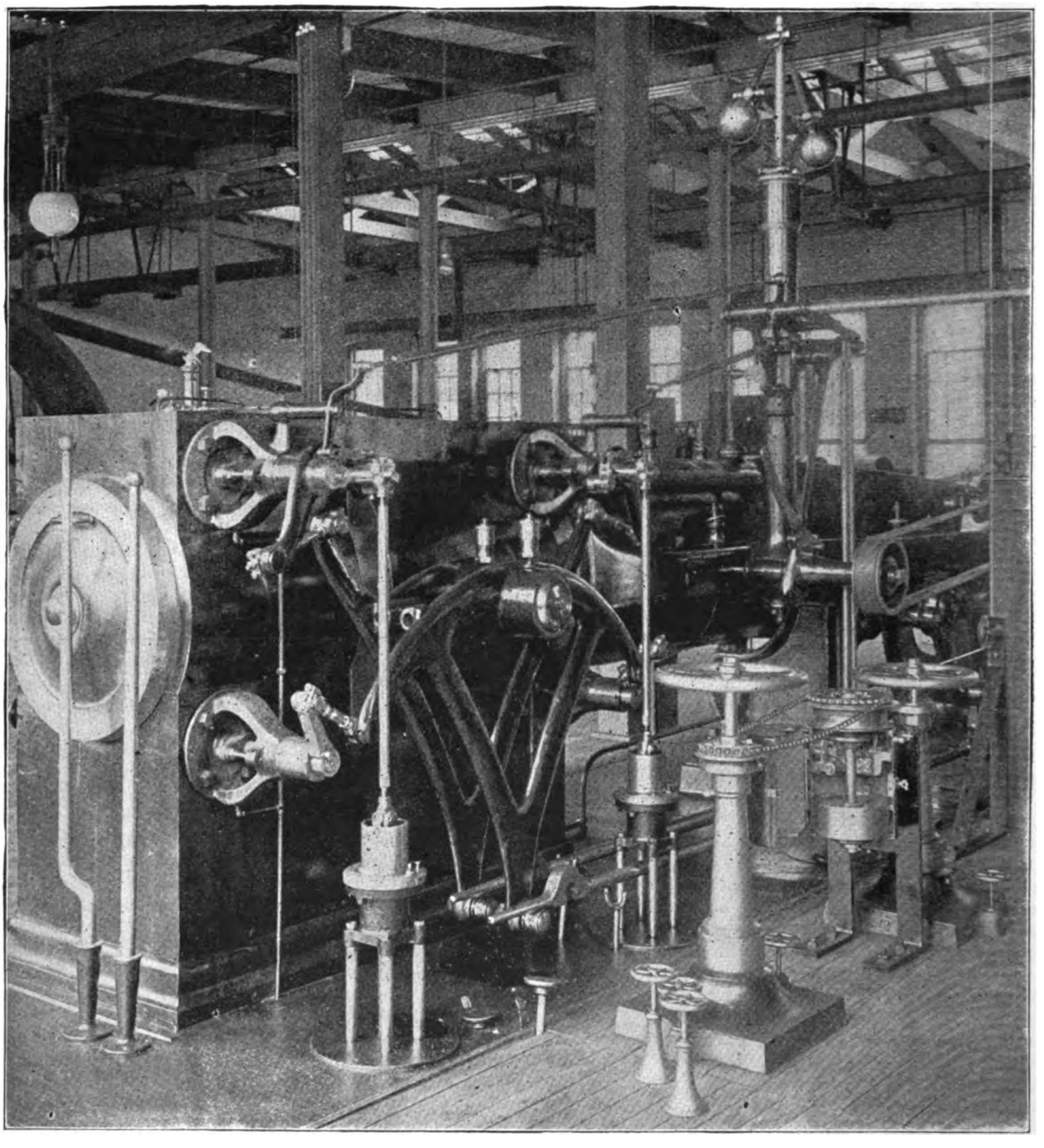
As regards primary batteries there has been, of course, as we all know, considerable progress since the time of Volta. The number of forms brought into use has been enormous and they have been important in increasing our knowledge of the relative electromotive force of various combinations and in their bearing on chemical knowledge. It can hardly be said that an ideal primary battery has yet been obtained, when we look at the subject from a commercial point of view. Although the subject is not very much to the front at preseut, however, it is destined to come again, and will, I have no doubt, be, in a comparatively short time, one of our leading industries.

(To be continued.)

Oakland, Md.—The Mayor may be addressed concerning erection of electric light plant, for which $25,000 worth of bonds will be issued.

MONARCH STOP AND SPEED LIMIT.

We wish to call the attention of our readers to one of the most ingenious inventions on exhibition at the Electrical Show in this city. This is a practical and reliable device for shutting off steam by a touch of the finger. It is called the Monarch Stop. The stem of the throttle valve is connected by sprocket wheels to this Stop by means of a sprocket chain. By touching an electric button an electro-magnet operating within the Engine Stop



Engine Stop Placed on Floor.

allows this sprocket wheel to turn, and it thereby shuts off the steam supply. The sprocket wheel is set into rotation by means of a weighted flexible wire rope coiled around an adjoining drum, so that it will instantly uncoil when a small pawl operated by the electro-magnet withdraws its restraining hold. A spring would perform the function of rotating the sprocket wheel as well as a descending weight.

When the button is pressed the magnet is energized,

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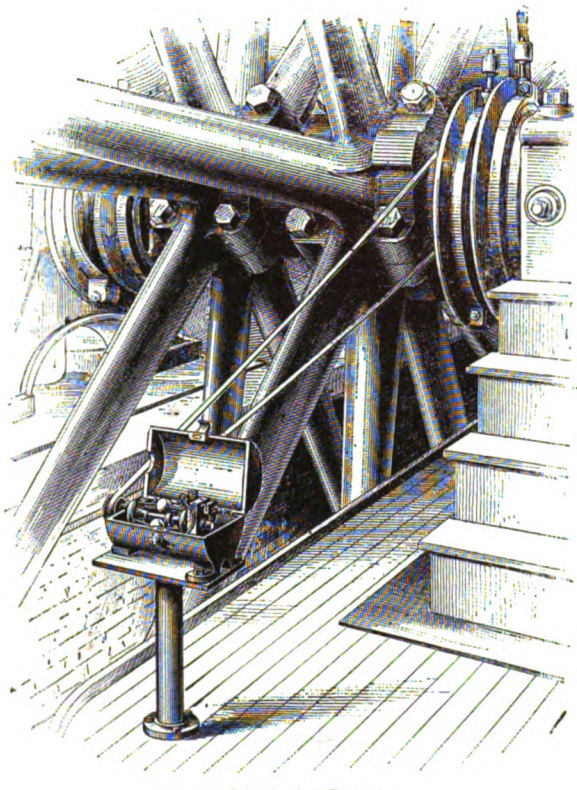
its armature is attracted, the pawl pulled out of the ratchet wheel, and the sprocket wheel, rotating, cuts off the steam supply, but not too rapidly. A dash-pot delays the last few revolutions of the throttle-valve stem, and thereby allows it to close gently and without jamming down hard upon its seat. This device is merely used for shutting off the steam, and this action may be controlled from any part of the building where a push button may be installed for this purpose. Thus the risk attending the operation of dangerous machinery, belting, shafting, etc., is reduced to a minimum, to say nothing of the saving of property following the breakdown of machinery. This Stop can be used for closing any valve, and it has met so far with wide application.

The Monarch Speed Limit makes a fly-wheel accident impossible. It consists essentially of a governor so



Speed Limit in Position.

mounted that it will close a circuit when rotating at a certain maximum speed limit. It is always used in connection with the Engine Stop, being driven by a belt running over the crank-shaft of the engine. The movement of the governor balls advances a sliding collar. The position of this collar is determined by the speed at which the balls rotate. It is possible to adjust this speed limit so as to make it applicable to an engine of the high or low-speed type.

Both of these devices, the Speed Limit and Engine Stop, are enclosed in dust-proof iron boxes, provided with Yale locks. The Monarch Manufacturing Company have their office at 39–41 Cortlandt street, New York city, where they will receive correspondence and orders relating to these machines.

THE EFFECT OF ARMATURE INDUCTION UPON THE ELECTROMOTIVE FORCE CURVES OF AN ALTERNATOR.

(Continued from page 285.)

An inspection of this curve shows that it is distorted in the direction of the normal rotation of the armature Thinking that its unsymmetrical form might not be entirely due to a magnetic reaction between the armature and fields, and that possibly it was caused, in part at least, by a variation in the width of the air-gap space, owing to the core of the armature not being quite true, the curve was continued through the complete revolution. The result of the test, however, gave another curve exactly like curve A. This indicated conclusively that lack of symmetry in the mechanical construction of the machine played no part in causing the distortion. The current in the coils 1 and 2 was then reversed in its direction while being kept at the same volume. The exploration resulted this time in giving the curve B, of Plate 1. As before, the "make" and "break" gave the same deflection for any given position, but the curve was found to be drawn over towards pole tips S′ and N, Fig. 2, instead of towards S and N′, as in the case of curve A.

The distortion of these curves, the ordinates of which are proportional to the inductance of the coils in various angular positions, is entirely due to the variation of the permeability of the iron composing the armature core and pole faces as the energized armature coils are moved through the half revolution. When curve A, Plate 1, was taken, the current passing through the coils tended to produce a magnetic field in opposition to that induced by the field circuit when the coils were in the 185° position, and one aiding the field flux when they were in the 95° position. In other words, poles were generated in the coils as indicated by the small N and S on coil 1 of Fig. 2. With the coils in the 95° position, when the circuit was made, a number of ampere turns were brought into action, which increased the induction in the surrounding masses of iron and at the same time decreased their permeability. With the coils in the 185° position, making the circuit through the armature, decreased the magnetic density in the surrounding iron and thereby increased its permeability. Breaking the armature circuit in either case brought the induction back to the same initial value, since the two positions assumed are symmetrically located relatively to the pole faces. The introduction of the same magnetizing force into the coils, however, does not cause the same variation in the induction threading the coils. Since the variation in the value of the permeability is in opposite directions in the two cases, the variation in the flux in the 185° position is greater than that which occurs in the 95° position, and therefore the self-induc-

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tion of the coils in the former is greater than in the latter, under the assumed conditions.

Magnetic hysteresis also plays a part in the variability of the armature inductance. As the armature revolves, the iron of the core passes through a complete hysteretic cycle once every revolution, and in making determinations of the armature inductance, account must be taken of the fact that the magnetization of the iron of the core follows the perimeter of the loop of hysteresis and not the "B and H curve," as the permeance of the core changes.

To determine the extent of the error introduced by neglecting to adhere to the true magnetic changes through which the iron passes, as is the case in the method so far described, a rather laborious process had to be resorted

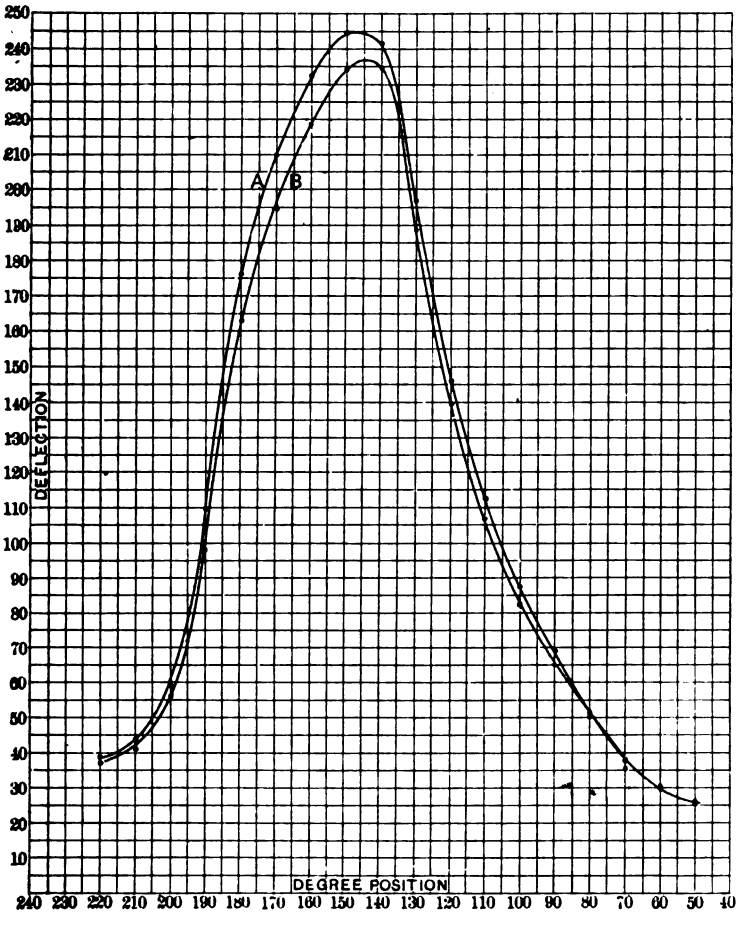

Plate 2.

to of carrying the iron in the core completely through the hysteretic cycle before taking each reading. By this means, owing to the fact that when a coil is between the pole tips the laminated core of the coil is highly saturated, it was possible to get a very fair estimate of the influence of hysteresis.

Suppose we take the hysteresis loop of Fig. 3 to represent the cycle through which the magnetization of the iron passes during a revolution of the armature. Let *a* represent the magnetic density in the core of coil 1 when it is in 230° position, and no current flowing in the coil. As the armature is revolved in a counter-clock-wise direction, the intensity of the magnetization in the core will decrease until at the 320° position it will have a value equal to *o*, *b*. At some point farther on, say at 330°, there will be a sufficient negative force to reduce the residual magnetism to zero, as at *c*, Fig. 3; and finally, when coil 1 reaches the 50° position, the magnetism will have been brought up to a negative maximum within the coil as at *d*. If at this point the circuit is made through the armature coils, and a constant current sent through them in the direction which aids the field flux, the density in the core will be increased to a still higher value, and rise up to *e*. Suppose now that the armature is revolved still further round, for instance, to the 120° position. The flux penetrating the coil will diminish to *f*. If at this point the armature current is broken by the snap switch, a current impulse will pass to the galvanometer needle from the exploring coil due to the decrease in the induction threading the coil from *f* to *g*. If, without changing the position of the coil, the current is made again, the density will rise to *h*, but will not come up to the original value at *f*. In other words, any number of "makes" and "breaks" can be made after the first "break" with the same result, but the first "break" will give a larger reading than the others. The first "break" gives the most accurate result. By this method, however, coil 1 has to be brought back to the 230° position before taking each reading, then revolved counter-clock-wise to the 50° position, and, after the current is made, has finally to be moved to a position between S′ and S, to take the reading at the "break."

Following out this method for one set of readings, curve A, of Plate 2, was obtained. Curve B is a curve plotted from an average of the readings due to the second and third "breaks" and their corresponding "makes." It is identical with a curve taken by the method used in

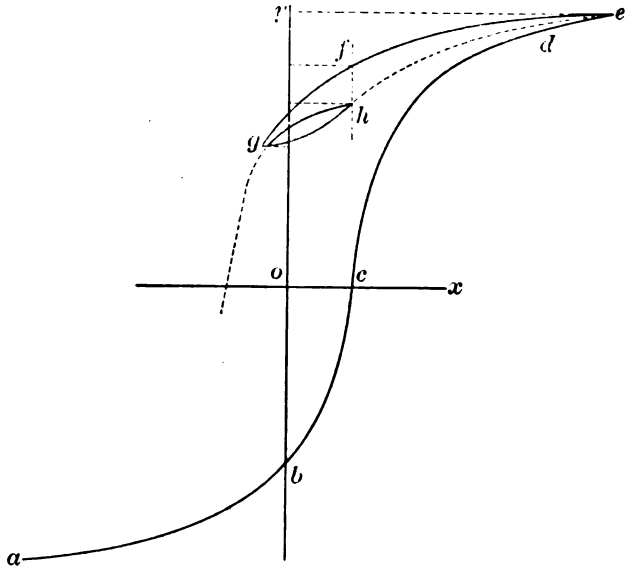

Fig. 3.

obtaining curves A and B, of Plate 1, but with the same armature current as that used in obtaining the curves of Plate 2. An inspection of the curves of Plate 2 shows that the maximum percentage variation occurs at the 190° position, where it amounts to 12 per cent., and that the maximum actual variation occurs at the 170° position, where it amounts to 15 divisions, or 7.8 per cent. of the deflection at this point. This represents an actual difference of .0117 henrys at the 170° position.

As was to be expected, from the considerations outlined above, the curve A of Plate 2 shows a greater distortion in the direction of rotation than does the curve B, taken by the less exact method. It reaches a maximum later in the cycle, and although of uniformly greater amplitude than curve B, the differences are most marked in the last half of the cycle, counting time from right to left.

Curves A and B are, however, exactly similar in form and so nearly alike, that it was not deemed necessary to follow out the more elaborate and exact method in succeeding determinations of the variable inductance, as the end in view was to determine the character of the changes occurring rather than the absolute value of them.

Plate 3 exhibits a series of these inductance curves. They represent five explorations, made with direct currents of different intensities flowing through coils 1 and 2, while the field exciting current was maintained constant at 10 amperes as usual. The readings have been

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THE MOST UNIQUE OF METALS.

The most precious metal is not always the most useful, and the demands of each age bring into prominence entirely through its use that metal which adds most to the comforts of man. The most precious metal in the strict sense of the word is, at the close of this century, undoubtedly iron, and not gold. When the proper amount of labor has been spent upon a piece of iron so as to mould it into the shape of hair springs, or the small blued screws used for watches, the ratio of value between one pound of iron thus formed and an equal weight of gold is at least fifty to one. The strangest property of metals is not to be found in their strength, density or hardness, but in what we might consider as something most unique; for instance, selenium, so to speak, winks when light falls upon it. This is made evident by the construction of a circuit in which a battery, galvanometer and piece of selenium form part. When a ray of light falls upon the selenium a deflection of the galvanometer needle is immediately noticeable, the light having reduced the resistance of the selenium, thereby allowing an increased current to flow.

The metal bismuth displays an equally interesting phenomenon; its resistance is greatly increased by the influence of a transverse magnetic field upon it. To state how far this effect is observed we might say that the resistance of bismuth isolated from a magnetic field and then exposed to one having a specific induction of one hundred thousand lines of force per square inch would vary as one to two. This wonderful property of bismuth is made use of for measuring the intensity of a magnetic field. It is very likely that this metal could be put to other uses, as, for instance, the measurement of the permeability of iron or any other magnetic material, or possibly for telephonic purposes where the magnetic field in a receiver is subjected to constant variations.

The discovery of these properties lead us to expect something of a similar nature in other metals. The effect of ether waves upon all the metals has not been tested at the present moment. The discrimination shown by selenium for visible rays and bismuth for magnetic waves may lead to the conclusion that all metals respond in a greater or less degree to the play of ether vibration upon them. No explanation has been made to account for the mysterious change due to light or magnetism striking these metals.

It seems likely to suppose that minute changes do occur in every case in which a metal is exposed to an ether stress, although why it is more pronounced in the case of selenium and bismuth than in that of zinc or silver is a sphinx-like puzzle. In considering the rather uncommon properties of selenium and bismuth, the extraordinary multiplying effects of iron upon a magnetic field must not be forgotten. We have in this case the theory of Ampere to believe in, but it is unfortunately only a theory, and the everlasting polarity of each iron molecule prevents its unbiased acceptance.

It seems as though a stress in the ether directly affected the molecular adjustment in both selenium and bismuth, although a higher rate of vibration was required for selenium than the other metal. We can only conclude from the above consideration that of all the laws operating in this universe very few are known to man; otherwise the rate of progress from an intellectual and commercial standpoint would be too rapid for our thorough comprehension.

"New Catechism of the Steam-Engine," by N. Hawkins, M. E., published by Theo. Audel & Company, New York, with chapters on gas, oil and hot-air engines, is in many respects a compilation covering the latest types of engines used for electric lighting and power. The great strides made in the use of appliances that are absolutely automatic have enabled the engine-builder to attach to the compound-wound dynamo a machine as reliable in its way as the generator itself, and these two automatic devices in conjunction require but a minimum of care and attention from the engineer in charge. It is a class of engines of this description that the New Catechism of the Steam-Engine mainly covers; other departments of the work include other types of engines and touch upon the principles of valve setting and the requirements of an able engineer, the chapters devoted to a description of gas and gasolene engines possess a deep interest for the enterprising contractor and builder. By carefully reading the contents of the New Catechism of the Steam-Engine the reader may become so familiar with the qualities and differences between types of steam-engines for high-speed work, and the valuable features of gas and oil engines, as to be able to judge of the suitability of any one that a contract may call for. As a book of instruction the above volume will meet with favor, but more as a compilation of a purely practical character than as a text-book or a piece of scientific literature.

Halifax, N. S.—The Halifax and Bedford Electric Company, which is seeking incorporation, is composed of Dr. Chisholm, ex-Mayor Keefe, E. F. Freeman and others of this city. The proposal is to build a road between Halifax and Bedford, with such extensions as may be approved by the municipalities. The head office of the company will be in this city. The capital stock is estimated at $250,000.

Chicontimi, Que.—Mr. Jos. D. Guay and Joseph Gagnon contemplate the construction of an electric railway in this vicinity.

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reduced to henrys; the calculation of the values being based upon the supposition that the inductance of the two coils at any point is proportional to the change in the number of lines of force existing in the coils at that point, divided by the current flowing in the coils and producing the change. The plotted values, therefore, represent the inductances of the two coils in series, proper allowance having been made for the fact that the exploring coil was only wound about one of them.

The curves of Plates 4 and 5 have been derived from those of Plate 3. They show the relation between the

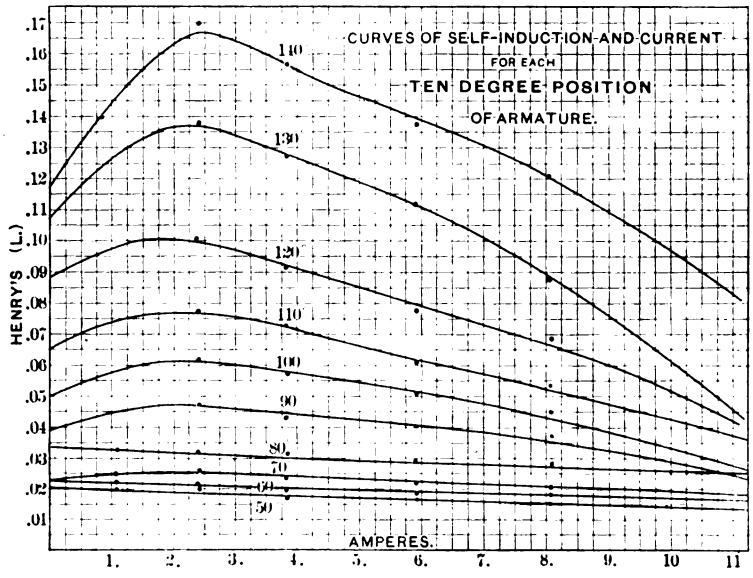

Plate IV.

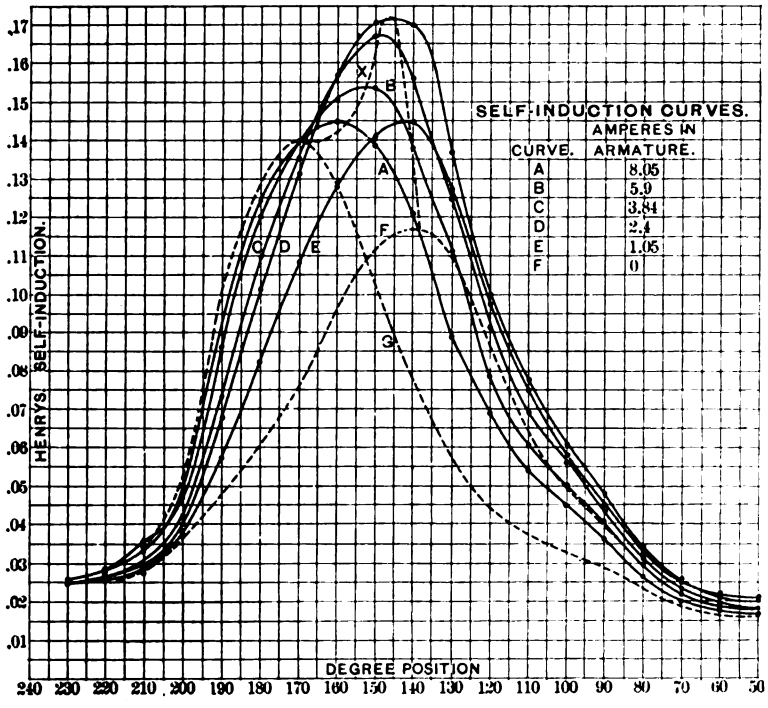

Plate III.

direct currents flowing in the coils and the inductance of the coils, and are useful when it is desired to determine the curve of instantaneous inductance that corresponds to a given alternating-current wave.

The curves of Plates 3, 4 and 5 bring to light some very interesting facts. They show that the maximum coefficient of self-induction occurs when the coils are in the 145° position and the current flowing in them has a value of 2.5 amperes; under these conditions their inductance is over .172 henrys. They indicate that as the armature current is varied from zero up to its maximum safe value, the inductance of the coils undergoes very marked and relatively rapid changes. The dotted curve F has been plotted from the ordinates of the curves on Plates 4 and 5 that correspond to the zero value of current. It represents the initial inductance cycle, and is the basic curve to either side of which the inductance curves for the various currents fluctuate. Curve F is practically symmetrical relatively to the pole faces. Its crest occurs as the coils pass the centre of the pole faces, and it slopes equally on either side. The line X, drawn from its crest through the crests of the other curves, indicates the successive positions and values assumed by the maximum inductance corresponding to different constant currents, as the volume of these currents is increased from zero. The maximum-current capacity of the armature is 15 amperes, but the inductance is changed from its maximum initial value of 117 henrys to its maximum possible value of .172 henrys when the armature cunrrent reaches 2.5 amperes. Any further increase in the current causes the amplitude of the inductance wave to diminish and at 8 amperes it is only 85 per cent. of what it is at 2.5 amperes.

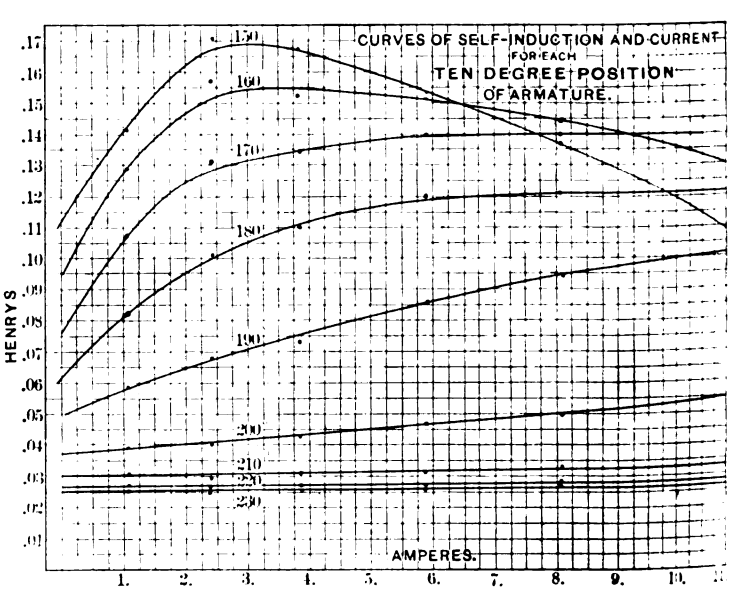

Plate V.

Besides varying in amplitude, the inductance waves undergo a lateral shifting in the direction of the rotation of the armature. The dotted curve G has been taken from Plates 4 and 5, and represents the inductance curve cor-

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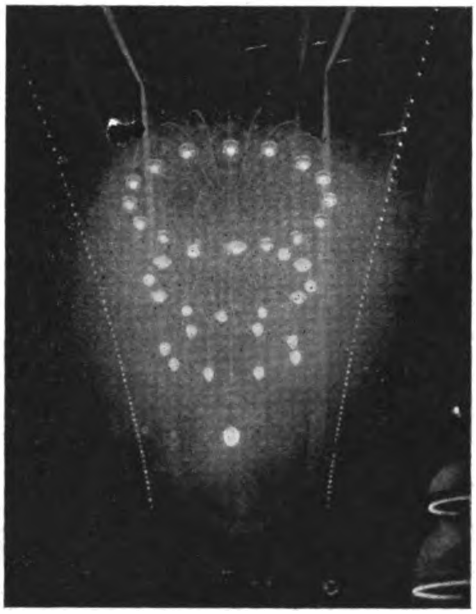
responding to 11 amperes. An inspection of Plate 5 shows that this curve practically marks the limit of the variability of the inductance. For a further increase in the current, the 170° curve of plate 5, tends to remain horizontal, and the 180° curve exhibits no disposition to rise appreciably beyond the 11-ampere point, there will therefore be practically no further shifting of the crest, or change in the amplitude of the induction curve.

To better appreciate the extent of the distortion that occurs, it is well to note that at the 170° position there is a difference of about .065 of a henry between curves A and F of Plate 3, showing that the inductance of the coils at this point has double the value at full load that it has at no load. This fact is brought out strongly in Fig. 4, which shows the differences between the ordinates of curves D, F and G. In this figure, the amounts by which the ordinates of curves D and G of Plate 3 differ from those of curve F have been plotted as ordinates relatively to curve F reduced to a horizontal base line.

(To be continued.)



The Big Arcolier at the Electrical Exhibition.

MADISON SQUARE GARDEN.

XPERT ENGINEERS visiting the Electrical Show have remarked that the race between the different manufacturing concerns is a very close one for best place. The exhibits will add greatly to their opinion that electrical machinery from a mechanical as well as an electrical standpoint represents the finest of workmanship. Visitors passing through the lower floor of the exhibit cannot fail to be impressed with the variety and excellence of the plants operating there. The development of electric lighting has increased wonderfully in the last few years, leading the engine manufacturer to higher and higher standards of excellence. Oil engine as well as gas engine men have the utmost faith today in the ability of their engines to stand the severest test that can be put upon them, namely: the running of a dynamo for electric lighting. In such a case uniformity of speed is so necessary that even an occasional variation would cause a fluctuation of light which would immediately condemn the source of power as being at times unreliable and deficient.

The Fort Wayne Electric Corporation, of Fort Wayne, Ind., exhibited in their booth an eight-light, 2000 c.-p., Wood arc dynamo, belted to and operated by a four-pole direct-current motor. The dynamo is fitted with the latest and most unique type of regulator, presenting the simplest, most compact and efficient constant current maintaining device known to practice. The regulator being complete on the machine does away with all wall controlling devices and outside regulator connections. The Fort Wayne exhibit consists in addition of one 37½ K.W., compound wound alternator of the low-frequency type (7200 alternations per minute) operated by a direct-connected multipolar motor. The alternator is loaded with enclosed, alternating current arc lamps and a bank of incandescent lamps, which by switches can be thrown singly or in groups on the corporation's latest types of ampere-hour, lamp-hour and K.W.-hour integrating recording meters. A five H.-P., single phase, self-starting, alternating current motor also receives its current from the alternator. An interesting mechanical device is shown in the shape of a commutator truing attachment which enables the operator to true a commutator by hand with all the accuracy obtained in a lathe. A combination arc and alternating-current switchboard transformer, small motors and several styles of arc lamps, complete this very interesting exhibit. It is one of the most interesting in the show and represents to a large degree the advances made in modern electrical engineering.

THE FARIES M'F'G CO.

The Faries M'f'g Company, of Decatur, Illinois, manufacturers of the Faries universal adjustable electric lamp holders, aluminum and steel electric lamp shades, and fire and water-tube boiler cleaners, have recently established an office at 136 Liberty Street, New York City, under the management of A. W. Koenig, and they request their patrons in the eastern states to send their inquiries and

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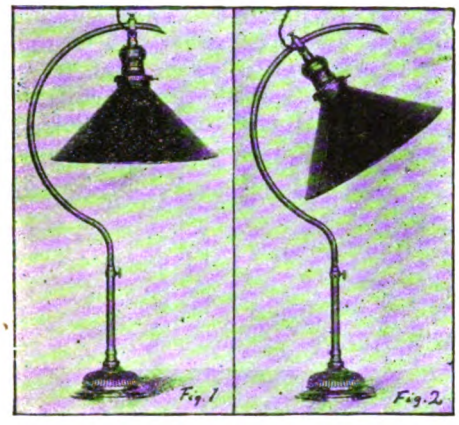
orders to this office, in order to save time and expense in shipping. Mr. Koenig has arranged a very neat, attractive and interesting exhibit at the Electrical Show, which you will find illustrated in this issue.

The exhibit is located on the promenade just above the main floor, adjoining the New York Telephone Company's Theatrephone exhibit, and we would advise all our readers who visit the show to call and see it, as we are positive the universal adjustable electric lamp holders exhibited by this company will interest everybody, both electrical contractors, engineers, electricians, electrical supply dealers, as well as the general public, who are fortunate enough to burn electricity in their offices or private residences.



Faries Student Lamps. Portable Tripod Stands.

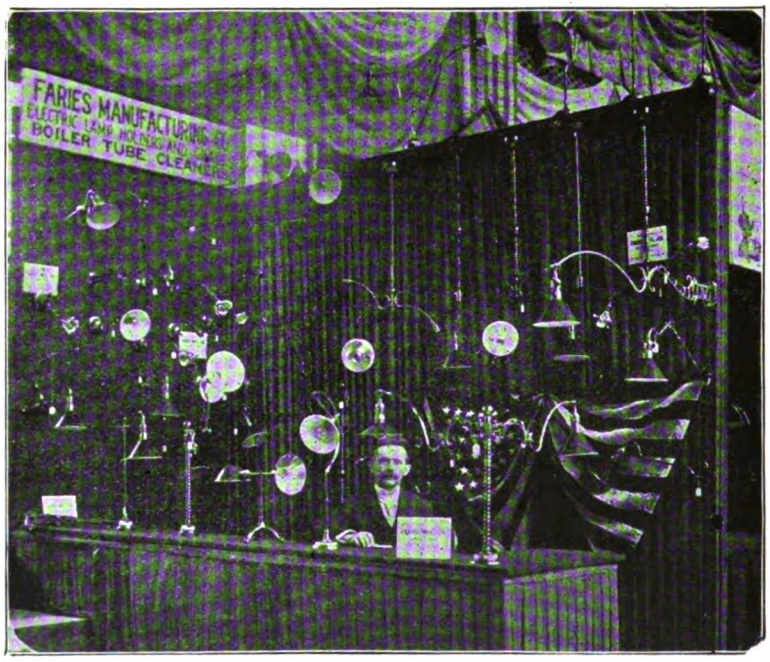
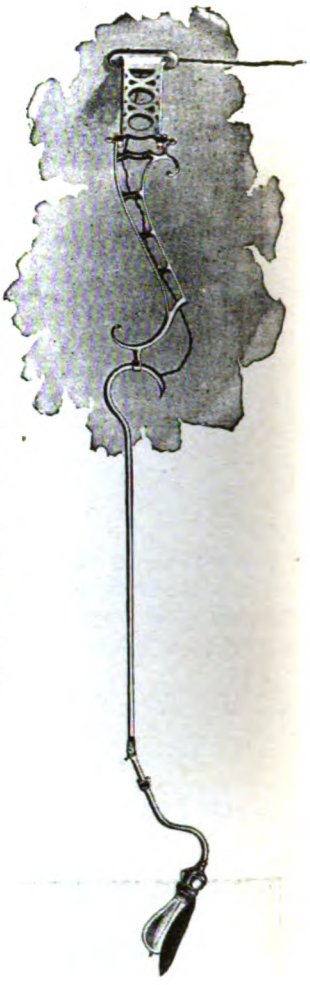


Exhibit of Faries Mfg. Co.



Faries Universal Adjustable Lamb Holder

The placing of the Faries universal adjustable electric lamp holders before the public meets the long felt want of being able to get your light just where you want it, and where it will be of service to you both in reading and working. Some of them are adjustable in four or five places, so that it is very easy to arrange them to throw your light anywhere you may wish it, by merely adjusting the fixture at any angle necessary.

These fixtures are manufactured of the finest material, and the best of workmen only are employed by the firm, so that no efforts are spared to turn out the best fixtures on the market at the most reasonable prices. They are made in about thirty different designs of portable and stationary desk and table lamps, side wall fixtures, chandeliers, pendent hall lamps, and dental lamps. They are all very unique and attractive in design, while not at all elaborate, thus making the cost very reasonable.

The aluminum and steel electric lamp shades or reflectors are made in three styles : the parabola or half shade, the cone shaped, and the ceiling shade. They are not only shades, but reflectors of the highest order. The holder reaches well over the shank of the lamp, leaving the shade to begin at the top of the filament, thus enabling a smaller shade of the same angle to cover the lamp as well as a larger one with old style of holder. Being smaller, it is lighter and less in the way ; being lighter, it is easier to handle and to be borne by light fixtures at different angles, and is not apt to rack or pull the socket to pieces as heavier shades are, They fit any socket and ore easier put on or off, and have a neater appearance than the old style of shade and holder. They are seamless, and are made both of steel and aluminum; both are enameled either black or green outside, and the steel ones are finely enameled white inside, while the aluminum ones are highly polished inside. The parabola has the further advantage of throwing the light to any angle.

The advantage of the fire and water-tube boiler cleaners manufactured by this company is that it expands when shoved forward, and collapses when pulled backward, so that it will never get stuck. It is easily adjusted for variations in sizes of tubes, and has a ram which enhances the ease and facility of operation, especially when tight and uneven places in the tubes are encoun-

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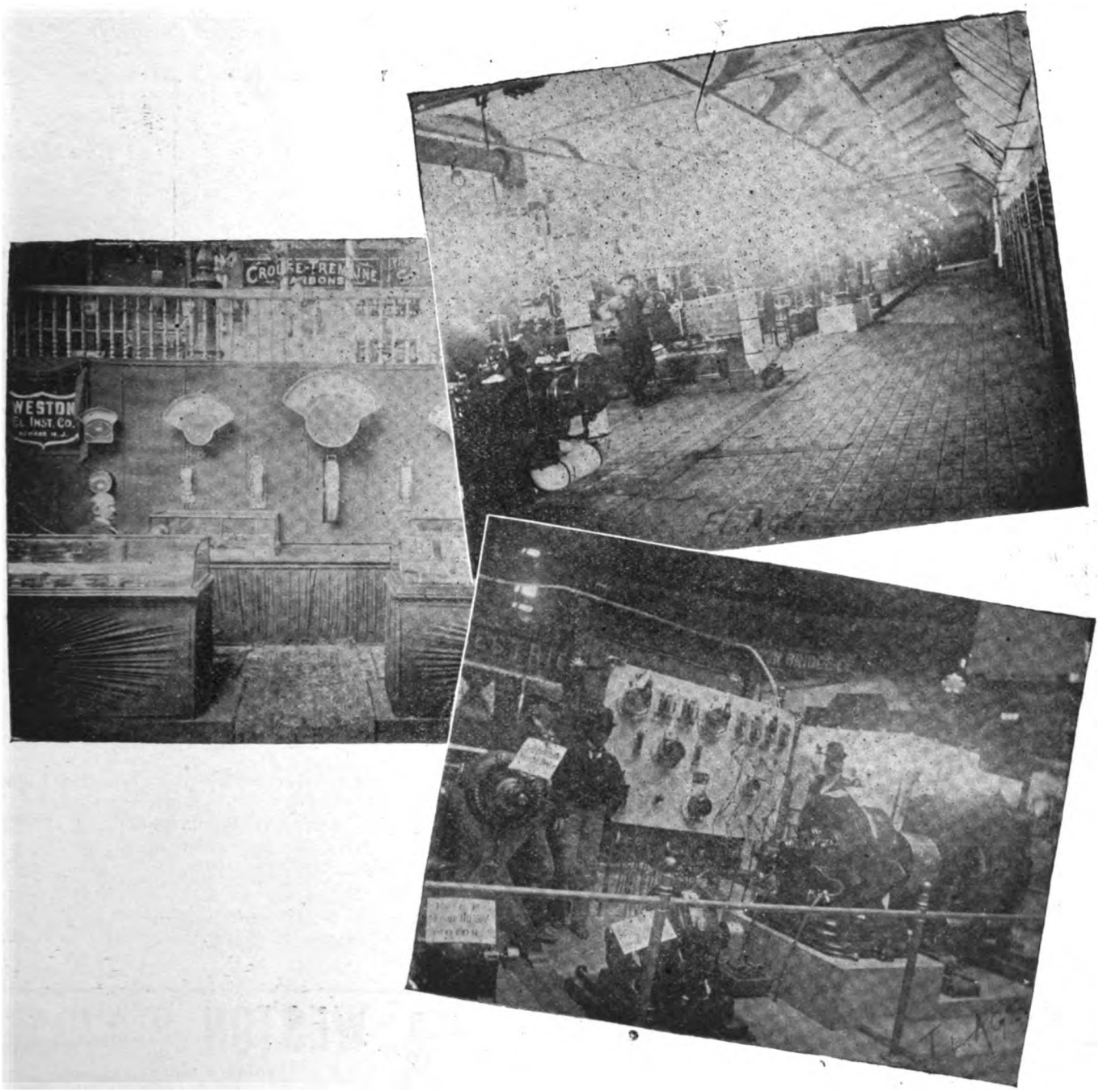
tered. There is no leather or rubber about the cleaner, and it does the entire work without the use of steam or water. We would advise all our readers to visit the exhibit of this company, but if you cannot find it convenient to do so, write them for a catalogue, which they will be pleased to send you on application.

THE BIG SEARCHLIGHT of the Ward Electric Supply and Construction Co. is attracting universal attention at their exhibit at the Electrical Show. It is the largest searchlight at the show and lights up even the far corners of the immense amphitheatre. The company is constantly receiving inquiries in regard to the searchlight, and have sold a number of similar ones to distant points in the United States. The Ward Company's exhibit of carbons for open and enclosed arc lamps has already brought in a large return of orders. Their array of arc lamps is the talk of the show and a number of orders for the same have been booked. The Ward Electric Supply and Construction Company are general electrical contractors and dealers in "Ward" and "Knight" arc lamps. They are also the Greater New York agents for the "Washington" carbons and general electrical supplies. The officers of the company are Eugene H. Levy, Jr., president and treasurer; Chas. O'Keeffe, vice-president; and Deronda Levy, secretary and general manager. Mr. O'Keeffe, the vice-president of the company, is deserving of great praise for his energetic efforts in behalf of the success of the Electrical Show, and also for the fine showing his company is making there. He is a practical electrician of many years standing, having held a number of very responsible positions, and is always on duty at the store of the Ward company. The office and salesrooms at 39-41 Ann Street, are filled with electrical supplies of every description.



Weston Electrical Instrument Co.

View in Basement of Garden.
Fort Wayne Electric Corporation.

WALTER DIXON, M. I. E. E. and F. R. M. S., of the firm of Miller, Dixon & Co., electrical engineers, Glasgow, Scotland, has been visiting the Electric Show all the past week. He is closing contracts for all of their electrical goods for his market.

By a general inquiry among exhibitors at the Electric Show we find that a fine trade has been carried on; many

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orders have been placed and some valuable missionary work has been done.

THE BEAUTIFUL MISS LIBERTY in J. Jones & Sons' exhibit is attracting unusual attention. The Miss whose name is drawn first from the box gets this fine doll. Mr. Lowe, the general manager of J. Jones & Son, 64 Cortlandt street, was in attendance during the past week and was in great demand. Mr. Lowe takes personal pride in their new enclosed arc lamp in the exhibit. This lamp attracts the attention of buyers and electrical engineers generally. There are no magnets, dash pots or mechanism operating the lamp. All that operates the lamp is a thermostat in the top, which actuates a clutch near the top of the enclosed bulb.

The Gordon-Burnham Battery Company have removed from 82-86 West Broadway to more commodious quarters at 594 Broadway. They report the business outlook as favorable, and are being taxed to their utmost capacity to fill the constantly increasing orders for their popular line of goods.

THE CONTINUOUS CURRENT TRANSFORMER.

The larger manufacturing concerns are now paying particular attention to the design and construction of continuous-current transformers. The great advantage derived from their use has added to their popularity and provided a place for them which is as well defined as the position occupied by the alternating-current transformer. Continuous-current transformers or boosters merely represent a combination consisting of a motor coupled direct to a dynamo of equal power. For electric lighting, railway work, etc., the use of these machines supplies a long felt want.

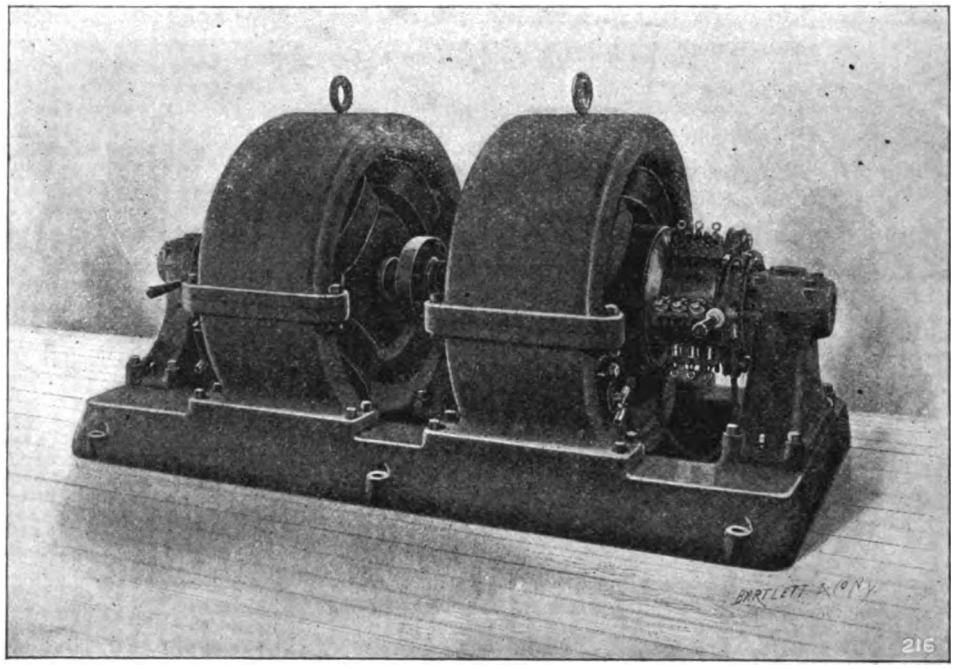
One of our most enterprising concerns, the Crocker-Wheeler Electric Company, make a specialty of building boosters, one of which we illustrate in this article. For power transmission there is no machine that can take its place. They are perfectly automatic, have self-oiling bearings and all the proper requirements in the shape of a perfect magnetic circuit, cool running windings and sparkless commutators.

The Crocker-Wheeler exhibit at the electrical show contains, besides this innovation, many other types of machines of a highly interesting character. The booster, however, fulfils its functions in a most unique manner, as it can be used not only for boosting but for lowering the pressure when required.

"LESSON LEAVES" and article on "Insulation and Conduction" will be continued in our next issue.

OBITUARY.

May 30.—As we go to press with our May 28th issue, we learn the sad news of the death of Mr. Fred Noll, so long associated with the Interior Conduit Company and Sprague Electric Company. No. 1 R. A. M. Masonic Order are to hold services at his late residence, Plaza street, Brooklyn. We mourn his departure.



Continuous-Current C.-W. Transformers.

Philadelphia, Pa.—The Philadelphia Electric Light, Heat and Power Company has been incorporated by G. R. Green, J. R. Enbery, H. R. Barramore, J. J. McCarthy and Henry Watts. Capital stock, $1,000.

Montreal, Que. — Messrs. Prefontaine, St. Jean, Archer and Decary are solicitors for the North Shore Electric Railway Company, which propose to build an electric line on the north shore of the St. Lawrence river.

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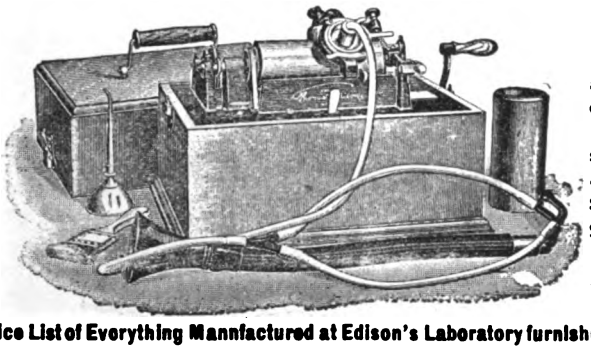

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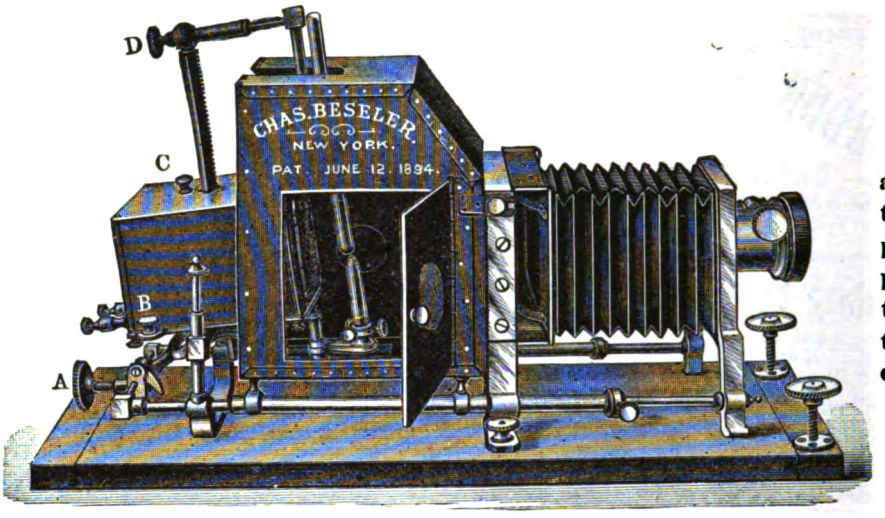

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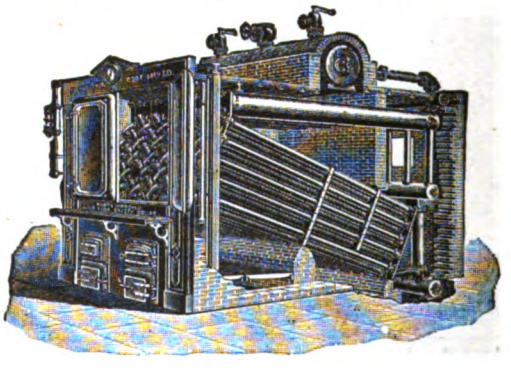

Selected by leading Electric Light Plants and Street Railway Companies throughout the United States. The following are the acknowledged requirements in water-tube boilers: *Straight tubes which can be thoroughly inspected and cleaned inside and outside; perfect suspension, allowing free movement of whole boiler expanding and contracting; perfect flexibility for the difference in expansion between upper and lower tubes; interchangeable parts, built to fixed standards; facilities for making quick and easy repairs which can be done by your own engineer or machinist; a cover joint which can easily be made tight, and frequently broken and replaced without injury; provision made to introduce the feed water where it will not chill and moisten the steam; provision made to carry feed water impurities direct to the mud drum and not past the ends of the tubes; provision made to supply the lower tubes with a bountiful supply of cool water; the use of the best materials and fittings the market can afford; the best possible workmanship; a large disengaging surface for the steam to escape from the water; small cast iron pressure parts; ample heating surface to prevent injury to parts should boiler be forced above its rating.*

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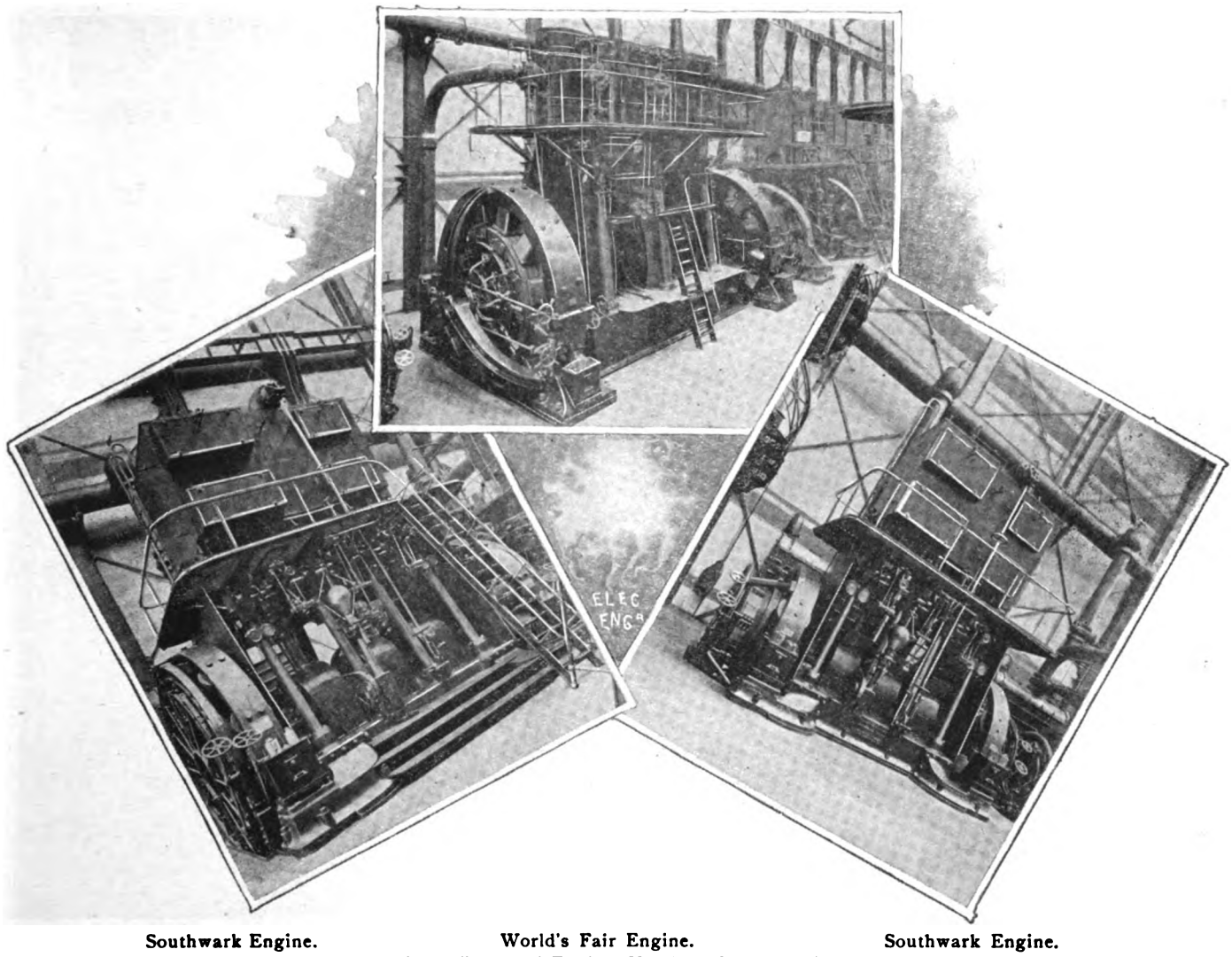
The Electrical Age.

VOL. XXI—NO. 23 NEW YORK, JUNE 4, 1898 WHOLE NO. 577



Southwark Engine. World's Fair Engine. Southwark Engine.

The Three Types of Engine, Harrison Street Station.

THE CHICAGO EDISON COMPANY'S ELECTRIC POWER PLANT.

The development of electrical enterprises in Chicago has been unequalled in the record of any other American city. The gigantic plant installed there by the Chicago Edison Company marks an epoch in the history of mechanical and electrical engineering, which is in its way as great as that period of architectural design which gave rise in ancient Egypt to the great pyramids and obelisks and mighty Sphinx.

Through the Chicago Edison Company Chicago is brilliantly lighted at night and its cars all run by electricity. The original company was incorporated in the year 1887, on April 30th, and from it arose the great concern we now write about. The Harrison street plant in Chicago is situated on the river front, being bounded by Pan Handle, Chicago & Alton Railroads and Harrison street. The entire building is built of steel frame-work. The engine and dynamo room are over two hundred feet long, more than sixty feet wide, and sixty feet high. The magnificent equipment within of switchboards and direct-connected engines makes this generating station one of the most remarkable extant. More than 24,000 amperes is being fed to the different lines radiating from this station like the nerves of a great ganglion. This plant is doubly interesting; first, on account of its size, and, secondly, because the boilers are heated by burning oil, of which 9,000 gallons per day is used. The Standard Oil Company send it up on oil engines, which are shunted off to the station and their load of oil pumped into a receptacle consisting of four great tanks, each twenty-five feet long and eight feet in diameter. Each boiler is heated by means of five burners, the steam being atomized before use. The boiler pressure resulting from this combustion is 175 pounds. Each of the above-mentioned tanks holds 9,300 gallons, the entire series when full being capable of supplying fuel for four and one-half days. Water is fed into the boilers from the Chicago River, being filtered before use. The pumps forcing it on its way have a capacity of delivery equal to 5,000 gallons per minute.

The cleanliness of this plant due to the use of oil; the absence of all smell and smoke, makes it superior to all plants of its kind in the world. The ten triple-expansion engines are used for driving the dynamos, each engine operating in direct connection with two General Electric multipolar generators. The engines represent two sizes; four smaller rotating the armatures of eight 200 K. W. generators, the other six engines turning twelve 400 K. W. generators. The Southwark Foundry & Machine Company, of Philadelphia, supplied eight of these engines. Special condensing apparatus is supplied with each engine, Wheeler surface condensers being used. Two large Edison engines that came from the World's Fair, along with the eight Southwark engines, complete the number in use. Of these, the smaller run at 157

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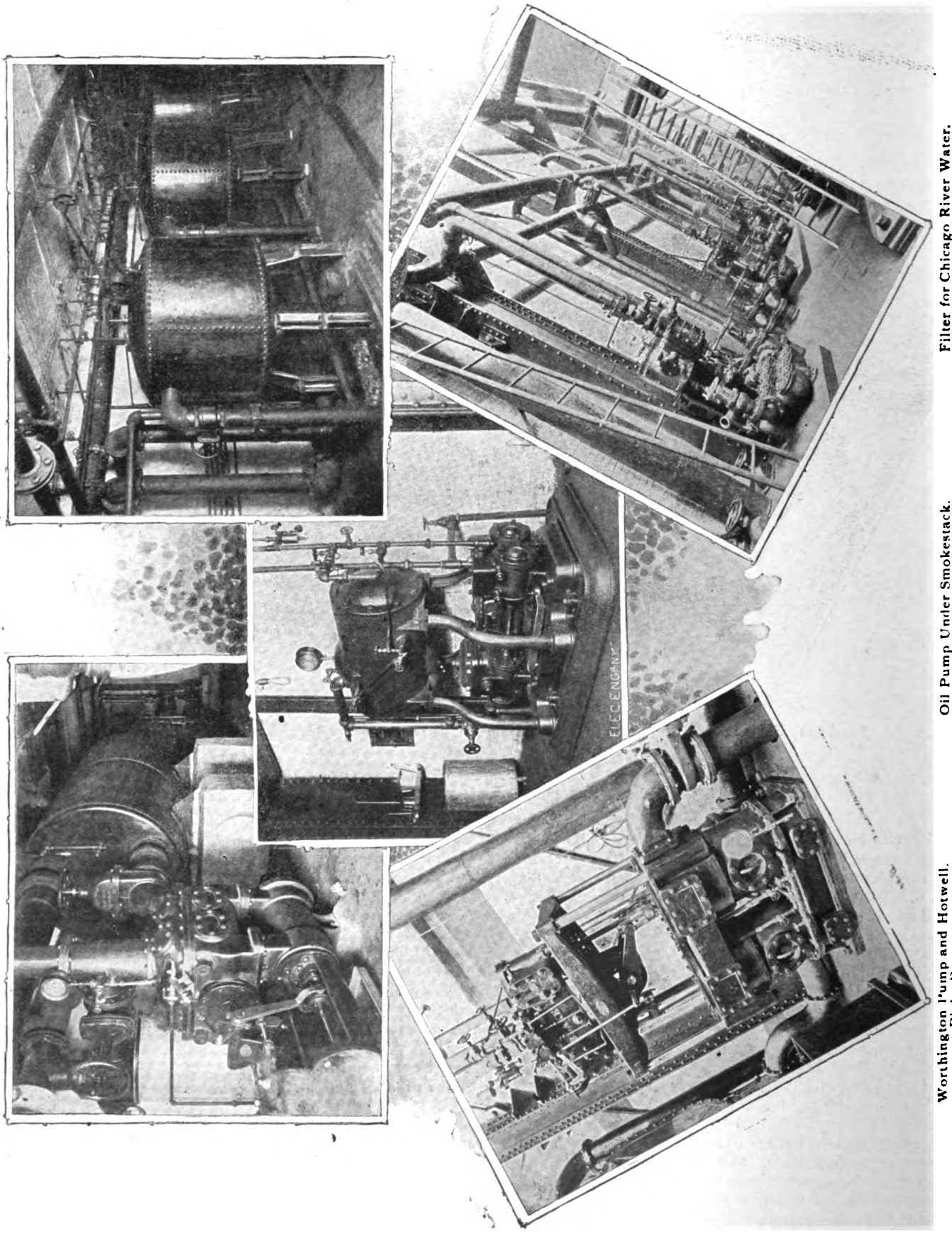
revolutions per minute, and the larger at 128 revolutions per minute. Every means has been taken to build this plant so that it will represent the best possible arrangement in the utilization of floor space.

stand all load variations without fluctuations of pressure. The armature of each is slotted and filled with bar conductors. The 200 K. W. machines have eighteen brushes apiece, three in a line and six sets. They give



Filter for Chicago River Water.
Boiler Feed Pumps.
Oil Pump Under Smokestack.
Worthington Pump and Hotwell.
Blake Pump.
Some Detail Apparatus of the Harrison Street Station, Chicago Edison Co.

In the illustrations are shown the types of engines used in the Harrison street station; also a view of the pumps for oil and water, as well as the filters purifying that taken from the Chicago River.

The large dynamos installed operate sparklessly and fifteen hundred amperes at 155 volts. The Edison three-wire system connects to this plant and includes the lines stretching out and circling the city.

The growth of the Chicago Edison Company's work in the six years dating from 1889 to 1894 shows an increase

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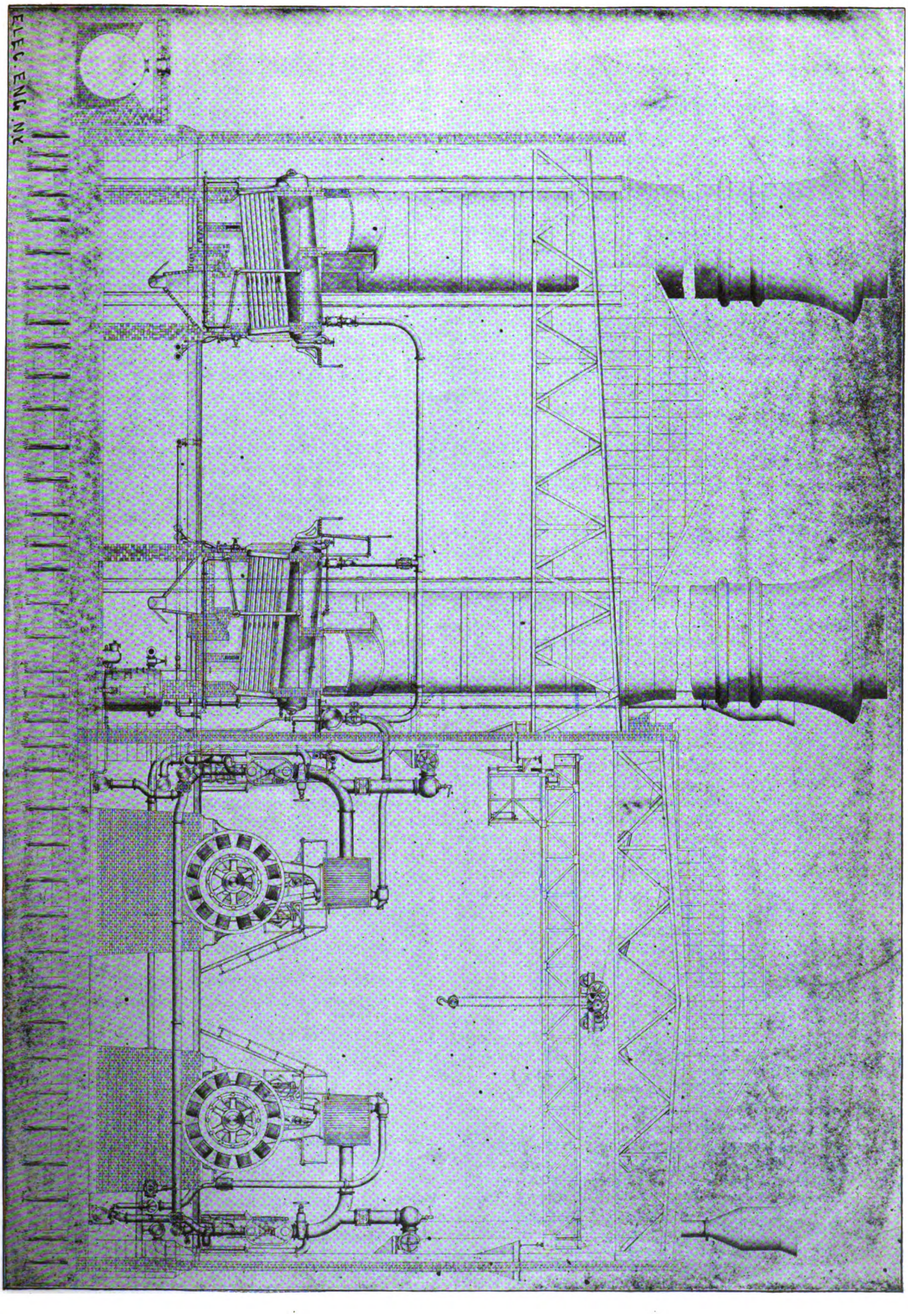

Section of Harrison Street Station through Engine and Boiler Room.

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of over 140,000 lamps, the total in 1889 amounting to 18,000, and in 1894 to 162,000. The use of electricity for power purposes likewise increased, so that the capacity of the plant was called upon to supply the equivalent of more than a quarter of a million 16 candle-power lamps. Many of the large buildings of Chicago prefer to use the company's current instead of installing their own plant. Monadnock Block, for instance, takes 8,000 lights, and the other large buildings in proportion.

The immensity of this great plant and the tons of copper buried underground carrying its current to all points within the city limits stamps this installation as one worthy of historical recognition in the annals of the world's progress. The president of the Chicago Edison Company, Samuel Insull, is likewise president of the National Electric Light Association, which meets in Chicago during the week of June 6th. Mr. J. W. Doane is vice-president, and F. S. Gorton secretary and treasurer. C. H. Wilmerding acts in the capacity of general superintendent, and W. M. Anthony fills the office of comptroller. The electrical engineer of this great plant is L. A. Ferguson; purchasing agent, Chas. Holmes; superintendent of low-tension system, W. L. Church; superintendent of high-tension system, R. S. Kelsch. Mr. Fred. Sargeant is the supervising engineer. The great switchboard, which is one of the most prominent features in the generating station, was designed by A. B. Herrick.

Since the subject of electric light and power has become one of great commercial importance, the study of electric light and power plants built on a large scale has occupied the attention and time of many eminent engineers. The great problems relating to the choice of fuel and its combustion, the utilization of waste heat, the generating of high or low pressures, and the most economical lamp to use, involve sums of money amounting to millions. The financeering and management of these large installations in consequence requires the aid of men of veteran business experience and broad mental grasp. The advances made each year in the great field of electric lighting calls upon the intelligence of those entrusted with the responsibilities of a large plant in a peculiar way, forcing them to be keenly alive to innovations of benefit and use and to refuse to consider those inimical to the growth and success of the corporation. A power of discrimination backed up by sound commercial experience are the two necessary elements upon which depends the income and dividends of any great electric light plant. In the past and present history of the Chicago Edison Company these factors have been actively operating for its benefit and prosperity.

THE MOORE EXHIBIT AT MADISON SQUARE GARDEN.

It is doubtful whether any exhibit, at any show in times gone, surpassed in interest that arranged by Mr. D. McFarlan Moore, the pioneer in practical vacuum tube lighting, and on exhibition at Madison Square Garden.

It is spectacular and therefore deeply interesting to the general public, but at the same time it is intensely scientific, and therefore interests the whole scientific world, so that everybody, from the conservative college professor to the simple child, is pleased. It comes at an opportune time because of the wide publicity already given to Mr. Moore's work and inventions. It will be remembered (especially by the 86,000 eye-witnesses) that Mr. Moore was the first to show the public, in 1896, what vacuum tubes really were. But that exhibit is making ancient history by his present effort, which is making scientific history.

All scientists say that vacuum tubes will be universally used some day, and from present indications that day is not far distant.

In July, 1894, Mr. Moore wrote a magazine article—the first of its kind—in which he made a sketch of how he thought vacuum tubes could and would be applied to church lighting. His present exhibition now makes his prophecy a reality. His architectural design—pure Gothic—for the chapel could not be improved upon.

In connection with the chapel exhibit Mr. Moore has carried out a pet idea of his, which in itself is an enormous attraction—viz., to give the public a chance to become personally acquainted with electricity.

One enters through a narrow passage-way—Fig. 1—noting the steeple of the chapel in the distance. On a table extending along the side of the passage are arranged, in the order of one at a time, the special attractions, everyone of which is operated by every visitor by closing the various switches in succession. In fact, they comprise a five-minute course in electrical engineering.

The first is a simple bell outfit, consisting of battery, bell and push button, arranged so simply that everybody can understand it. Then follows an electric motor, which starts so suddenly as to frighten the innocent visitor into wondering what he or she had done. Next, a front door name-plate in vacuum tube letters. Electric fishing, poaching eggs by electricity, tube lighting by induction, and finally as one is handed a most beautiful souveuir in the shape of a miniature vacuum tube they all receive a shock.

The passage turns abruptly, and one sees in front a beautiful stone village church, steeple, clock and all—Fig. 2. The front doors are open, above the arches of which shine forth in vacuum tube letters, "Moore Vacuum Tube Chapel," and within is seen the vaulted roof ribbed with the most beautiful arches ever constructed—viz., made of long curved tubes of glass about two inches in diameter and glowing their entire length with a pure white light.

All artificial lights now generally used radiate from single points, while this light emanates from long tubes, making it the closest counterpart of daylight that can be obtained. The color of the light is such that it is invisible in daylight—proving their similarity. The temperature of the tubes is that of the room—that is, it is practically "light without heat."

The ear is also gratified with melodious strains from the magnificent pipe organ, which fills the far end of the chapel behind the nicely and thoroughly equipped altar—even to the Bible—Fig. 3. The soft, rich carpet under foot attracts one's attention to the specially-designed quartered oak pew with luxurious cushions—Fig. 4. The predominating color of the frescoing is yellow, and the stained glass windows look perfectly natural. The tube arches spring from pilasters, each capped with a highly-polished, specially-designed brass fixtures—Figs. 5 and 6. They take the form of a crown, while at the apex of the Chapel ceiling, where the tube arches meet, they are joined by a highly-decorated brass cylinder—Fig. 7—bent at its centre. The fixtures supporting the longitudinal tubes at the apex of the ceiling are shown in Fig. 8.

Of course, these are the first vacuum tube lighting fixtures ever designed, and are a striking example of the manner in which Mr. Moore has worked out the 1000 and 1 details of his lighting system. In this connection it should be mentioned that the chapel is wired completely with iron armored conduit, again inaugurating that which will soon become standard.

As one passes out of the exits on the sides of the organ it is noticed that the chapel is ventilated by two 24-inch exhaust blowers over the organ pipes. A last look is attracted by the colored vacuum tube letter sign over the rear door, "Let There Be Light." This is the same historic sign used by Governor Morton in opening the exhibit of 1896.

The church is wired with the Moore Three-Wire System of Vacuum Tube Lighting—viz., all of the tubes—16 arch and 3 ridge tubes—are connected in mul-

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tiple arc between three wires, the common or positive wire extending along the ridge, while each of the two negative wires extend horizontally along the sides of the chapel back of the side fixtures, which rest on top of the pilaster caps. The three wires enter the top of a polished oak cabinet, 2 feet by 2 feet by 4 feet, which contains all of the lighting apparatus, and is situated on one side of the entrance passage-way, as seen by Fig. 1. There also enters this cabinet (see Fig. 1) at the top the three wires connecting with the street service of the Edison Electric Illuminating Co.—again fulfilling a point first called attention to by Mr. Moore—viz., that vacuum tube lighting must make its start by being adaptable to the present commercial circuits.

It will be remembered that one of the salient points of Mr. Moore's system is breaking a current in a vacuum. This he accomplishes by means of a beautifully constructed scientific instrument which he calls a rotator—Fig. 10. Surrounding this rotator, which is of glass—3 inches in diameter and a foot long—is the gramme ring with its highly-polished brass mountings, which, as a whole, makes as beautiful a piece of scientific apparatus as has ever been constructed. This is all of the apparatus where multiphase currents are available, but in this instance the lower compartment of the cabinet contains a small rotary transformer. The system at its present stage of development has an efficiency about equal to incandescence, but since there are great opportunities for the development of the tubes—a problem Mr. Moore is about to take up—the final efficiency will be remarkable.

Besides the rotary vacuum-break, Mr. Moore has gotten into commercial shape a vibratory vacuum-break. This apparatus will be extensively used for advertising purposes (see Figure 11) for either direct-current circuits or alternate-current circuits.

There are also many other applications for this system of lighting. For example the color of the light, even to the most delicate shades, can be changed simply by changing the degree of vacuum of the tubes, making it the ideal light for special decorative lighting. Another large field is in connection with photography—for photographers have long been longing for a light which they could regulate to a nicety and thereby obtain uniform results. At the Electrical Exhibition in 1896 Mr. Moore took instantaneous portraits by his light.

It has long been a matter of expectation as to when and by whom vacuum-tube lighting apparatus would first be placed on the market, and the fact that Mr. Moore is now taking orders is extremely interesting, since it is a beginning of a new department of electrical business which is destined to grow to immense proportions.

BERNARD DECISION.

SEWARD DAVIS.

Judge Coxe has just rendered a decision in the suit of Edison Electric Light Company vs. E. G Bernard Company, et al., upon the Edison patent No. 264,668, for the compound winding of a dynamo, dismissing the complaint.

The Edison patent is declared to be invalidated by the patent to Charles F. Brush, No. 217,677, granted to Mr. Brush for this same improvement some three years prior to Edison's patent. The old Brush dynamos of 1878, built in accordance with his specifications, show completely satisfactory automatic regulation from no load to full load when running incandescent lamps of low voltage, such as are used at the present day in large cities for telephone exchange signals, where they are operated by compound-wound dynamos in all essential respects like the Brush compound-wound dynamos of 1878-9. In fact the Brush dynamos of twenty years ago can be put into operation where a modern compound-wound dynamo is used, without any modification or change whatever, so that if the Edison patent were sustained, it would involve the enjoining of the use of dynamos built for the same purpose as that set forth in the Edison patent No. 264,668, and built four years before the date of his application.

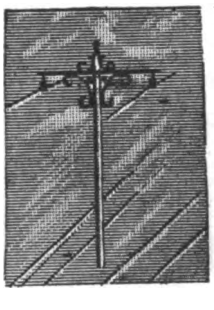
The opinion is very flattering in its commendation of Mr. Brush and his early work. The decision is very far-reaching, as stated, since the General Electric Company sought to extend the scope of the patent to include in its broad claims any dynamo having a compound winding of its field magnets, whether separately or self-excited, in combination with any translators in multiple-arc, whether lamps, motors, or electroplating baths.

A GOVERNMENT ORDER FOR THE CRESCENT TELEPHONES.

The Pennsylvania Electric Company of Marietta has received a large order for telephones from the War Department, to be used for all the forts, coast defences and signal stations along the Atlantic Coast. The company received instructions to rush the order. This is quite a compliment to the Crescent Telephone apparatus, as no doubt all other makes were considered before the order was placed. The Crescent Telephone embodies later improvements than any other make of telephones on the market.—Marietta (Pa.) Times.

The litigation over the right to make and sell music records and other sound records for talking machines, has been brought to an interesting point by an order made by Judge Wheeler in the United States Circuit Court of the Southern District of New York, adjudging Messrs. Cleveland Walcutt & Edward F. Leeds guilty of contempt. The proceeding against them was commenced last fall by the American Graphophone Company, which company claimed that their patent rights were violated by Walcutt & Leeds in making, using and selling duplicate sound records. The defendants were enjoined from making, using or selling such records made on machines not procured from the plaintiff or under the plaintiff's patent. Subsequently the firm of Walcutt & Leeds went out of existence, but it appears the two members of the firm resumed and continued business in connection with others, having formed a corporation called "The Walcutt & Leeds Company, Ltd." The Judge holds that this new arrangement does not make the acts of Messrs. Walcutt & Leeds any the less a violation of the injunction, and therefore adjudges them guilty of contempt. To give the defendants full benefit of all possible doubt of intent arising from a misunderstanding of the former decree, they will not be punished beyond making good the injury to the plaintiff by paying over, upon ascertainment, the profits and damages of the violation, with costs of the proceeding in default thereof to stand committed. Under the order of Judge Wheeler the defendants are not permitted to combine the machines sold them by the American Graphophone Company with any other device so as to produce duplicate records.

THE N. E. L. A. CONVENTION.



THE official programme of the Chicago Convention of the National Electric Light Association:

Tuesday, June 7, 1898.—Meeting of the Executive Committee at 9 a. m., secretary's office, Auditorium Hotel. Morning session, 10.30 o'clock, Convention Hall, Auditorium Hotel. Address, President Insull. Paper, Calvin W. Rice, Brooklyn, N. Y., "Cost of the Generation and Distribution of a Unit of Electricity." Topic, "Prices and Discounts for Electric

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POPULAR FACES AT THE N. E. L. A. CONVENTION.

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The Electrical Age.

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NEW YORK.

NEW YORK, JUNE 4, 1898.

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THE CHICAGO CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The last convention of the National Electric Light Association was held at Niagara Falls, June 8, 9, and 10, of last year. Business of considerable importance was transacted, and papers read relating to electric light and power. The Association has added to its prosperity year by year, and extended its membership list so as to include all electric light men of any consequence in the United States. The interest attached to meetings of this kind has increased year by year, until now wherever the Association holds its convention the citizens of that town regard it as a municipal event.

The papers read by the appointed members of the Association are written by men that have had an intimate experience with the subjects it is their privilege to discuss. The papers contained within the transactions of sister societies, that are supposedly of a more technical and scientific nature, will be found by comparison to be if anything only on a par with those delivered before the National Electric Light Association. The position the Associatien holds among the electrical fraternity is a most unique one. The members are well known to each other and in many respects have grown up together, so that the ties binding each to each are of the strongest character from a social standpoint. The diversity of experiences enjoyed by those constituting the active members of the Association enables them to exchange information highly valuable to those but partially initiated in the mysteries of electric lighting.

At the last convention at Niagara Falls the entire field of work was covered in so interesting a manner that many members awaited with impatience this next gathering. Aside from the instruction to be derived from these meetings, certain commercial relations are established, which possess considerable significance during the intervening year. Many supply men are on hand at the convention and other dealers in electrical apparatus.

The conclusions reached by those desiring to institute innovations in their central stations have enabled the supply dealers to develop a large and paying trade with many of the N. E. L. A. members, the convention work having in the end enough importance to influence many managers and presidents of electric light concerns to add to their equipment that which would be shown in the course of a discussion to be essential to the welfare and success of the plant. It is therefore seen that the N. E. L. A. conventions offer two great advantages to those attending it, increased opportunities for the transaction of business and a means of acquiring information of the highest practical value.

THE CLOSING DAYS OF THE ELECTRICAL EXHIBITION.

Those attending regularly to the exhibits at the Electrical Exhibition have noticed night by night an increasing interest on the part of the public in the various unique displays filling the great Garden. As a proof of this an observer will see many faces that seem to grow familiar as the nights roll on. It seems that many laymen whose occupations in life do not in any way run parallel with practical applications in electrical engineering repeat their visits frequently in order to gain sufficient acquaintance with the varied exhibits to be able to speak intelligently on such subjects. That at least seems to explain the frequency of their coming and going. The average New Yorker has no idea of the extent and variety of the apparatus utilized in the transmission of power, electric lighting, telegraphy and telephony and electric traction. The Electrical Exhibition gives the visitor an opportunity of gauging the extent of the development that has taken place in the different departments of electrical engineering within the last five years. It shows him that the closing days of the exhibition mark the dawn of a new era rich with its promises of multiplied inventions and bright with a future that will glorify it in the eyes of our twentieth century descendants.

TO THE TRADE.

The third annual convention of the fire and police telegraph superintendents and municipal electricians will be held at Elmira, N. Y., August 9th and 10th, 1898, at 10 A. M. All members are expected to be present. Bring your ladies; special arrangements are being made for their entertainment. Several papers will be read by well-known electricians. Will you be present? Fraternally, W. Y. Ellett, President; H. F. Blackwell, secretary. Take N. Y. C. R. R. & H. R. R.

Ottawa, Can.—The Canadian Electric Water & Power Co. has been incorporated by Hon. John Haggart, W. A. Allan, A. Charlebois, Sir Sandford Fleming and R. G. Code, for the purpose of manufacturing electric machinery and electricity for the purposes of light, heat and power in the cities and towns of Canada.

Pratt City, Ala.—Town Clerk may be addressed concerning construction of electric-light plant.

Arcadia, Fla.—J. L. Jones, Mayor, may be addressed concerning construction of electric-light plant.

Fitzgerald, Ga.—City Clerk may be addressed concerning construction of electric-light plant.

Lee, Mass.—The Lee Electric Co. will improve its plant and extend it to South Lee.

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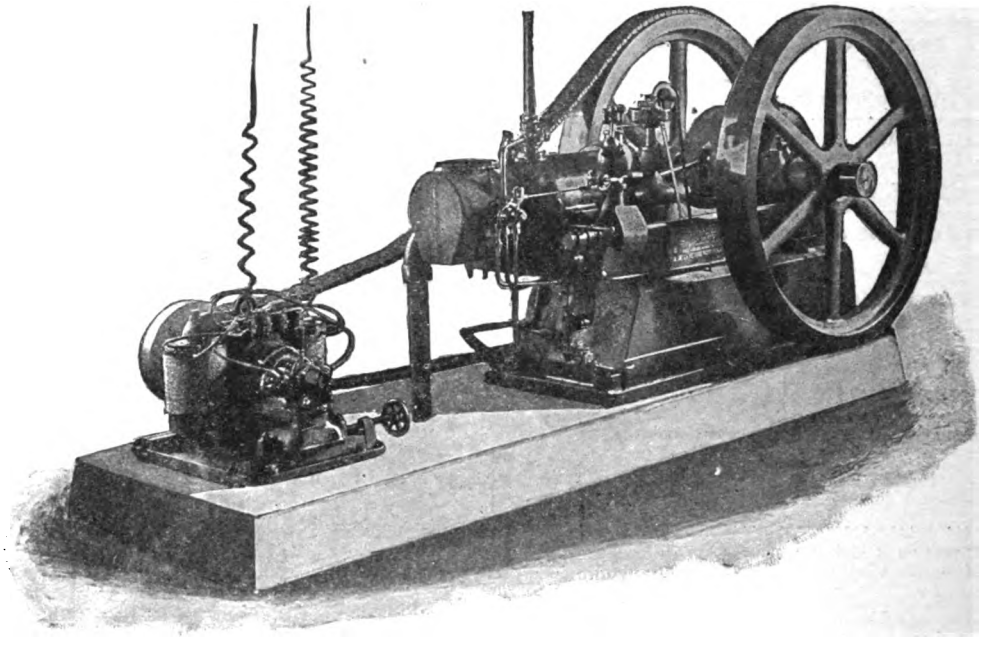
Current and Methods of Billing Current to Customers." Afternoon session, 2 o'clock.—Paper, Alex. Dow, Detroit, Mich., "Public Lighting with Relation to Public Ownership or Control." Topic, "Legislative Policy as to Public Service Corporations."



"Hornsby-Akroyd" Oil Engine with Dynamo.

Wednesday, June 8, 1898.—Morning session, 10 o'clock.—Paper, Herbert A. Wagner, St. Louis, Mo., "General Distribution from Central Stations by Alternating Currents." Paper, Louis A. Ferguson, Chicago, Ill., W. McLea Walbank, Montreal, Canada, "Cost of Producing Electric Power by Water Power from Lachine Rapids, Canada." Report, Committee on Standard Candle Power of Incandescent Lamps, Dr. Louis Bell, chairman. Questions and Answers. What Is It You Wish to Know? Executive session. Evening session, 8 o'clock, Auditorium Hall.—Lecture, Joseph Wetzler, "Electricity Direct from Coal" (illustrated with stereopticon).

Thursday, June 9, 1898.—Morning session, 10 o'clock.

De La Vergne Exhibit at Madison Square Garden, May, 1898.

"General Distribution from Central Stations by Direct Currents." Topic, "Standardizing Apparatus for Central Station Use." Afternoon session, 2.30 o'clock.—Paper, Paper, Prof. W. E. Goldsborough, "Transformer Economy." Report, Committee on Amendments to Freight Classification, James I. Ayer, chairman. Report, Com-

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mittee on Legislation Concerning Theft of Current, James I. Ayer, Chairman. Afternoon session, 2.30 o'clock.—Topic, "Freight rates on Electrical Apparatus." Report, Committee on Finance, James A. Seely, chairman. Executive session. Election of officers.

DOMESTIC ELECTRIC LIGHTING.

A home is really incomplete unless supplied with every means on the premises for giving light and heat. What were at one time regarded as luxuries in the home are now considered necessities. It will not be very long in conseqence of this change of opinion for the ordinary citizen to regard electric lights as indispensable factors in home comfort.

Attempts have been made by manufacturers of primary batteries to run electric lights with economy and convenience, but their efforts have proved fruitless. Since the number of suburban residents has increased and country homes and summer resorts multiplied, the demand for private electric-light plants has grown to large proportions. They require an electric-light equipment which can be attended to by a janitor or layman and make no demand upon the skill or experience of those in charge. The cheapest, simplest and most practical combination of this kind is to be found in the use of an engine using oil, the mechanical energy of which is transformed by means of a dynamo into electricity.

At the Electrical Exhibition the De La Vergne Refrigerating Machine Company show in actual operation an oil-engine plant consisting of the Hornsby-Akrovd oil engine driving a dynamo, by means of which the entire booth is brilliantly illuminated. Two engines are to be seen, one of 32 H. P. running at 170 revolutions per minute, the other supplying light through the medium of the dynamo, of four H. P., driving by link belt a C. & C. dynamo. Kerosene oil is used of which one pound per horse-power is consumed. The excellence of this plant is proven by the absolute steadiness of the electric lights. The engine, by means of which this remarkable regulation is obtained, operates on the Otto cycle principle with a single-acting piston and an explosion every second revolution. The oil consumption naturally depends upon the load the machine is carrying, the regulation being effected by this means.

The oil utilized in this engine is by means of a special device vaporized, mixed with air and then exploded. The retort within which ignition occurs is heated by external means before the engine is started. When this chamber is sufficiently hot oil is allowed to enter into it, vaporized, air mixed with it and complete ignition brought about by the walls of the retort. The amount of air admitted is the same at all loads, the only variable quantity being the oil supply. About forty pounds to the square inch is the degree of compression to which the mixture is subjected before its potential energy is utilized.

The certainty of ignition and absolute and automatic control of the fuel supply makes the Hornsby-Akrovd oil engine a most reliable and economical machine. The tank at the bottom of each engine carries sufficient oil to run it for many days. They can be made of any size desired.

The U. S. Government uses the Hornsby-Akrovd engine in preference to all others for its special naval and marine work in the operation of lighthouses and the running of fortification searchlights. It has even been introduced for running fog-horns of special construction, by the U. S. Government.

The De La Vergne Refrigerating Machine Company have their offices at the foot of East 138th street, New York City. The absolute safety of this engine has been the cause of many thousands of plants having been installed. In public exhibitions it has taken the first prizes, particularly so before the Royal Agricultural Society of England. Costing one-half as much to run this oil engine has displaced a great many gas engines, due to its cheapness of operation and certainty of action.

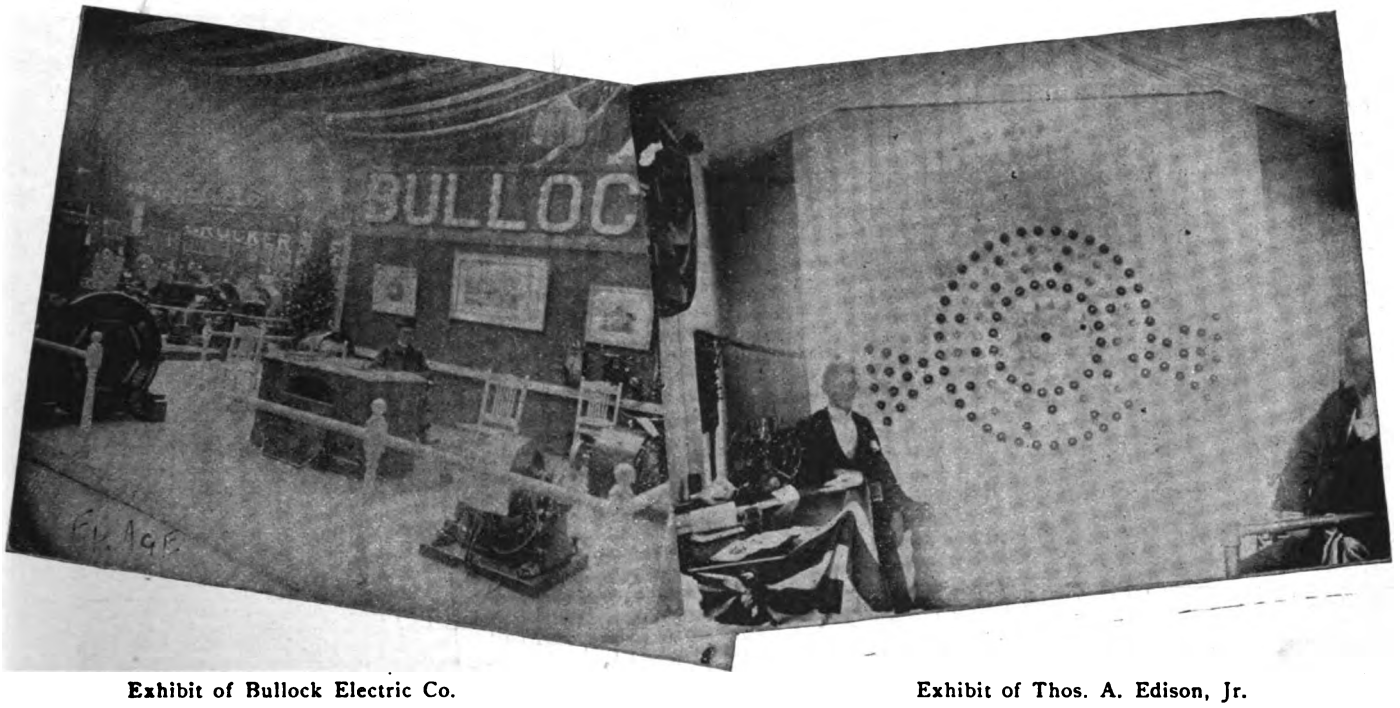

Exhibit of Bullock Electric Co.

Exhibit of Thos. A. Edison, Jr.

THE BRILLIANT DISPLAY at the booth of Thomas A. Edison, Jr., was remarked upon by all the visitors to the Electrical Show. Thomas A. Edison, Jr. was frequently to be seen in attendence and he and his colleagues were kept busy explaining the qualities of the Edison Junior lamp.

THE BULLOCK ELECTRICAL MANUFACTURING COMPANY, of Cincinnati, O., showed a full line of machines for light and power. The reputation of the Bullock motors has spread all over the United States. The largest printing and publishing establishments in the country favor the Bullock motors, on account of its excellent finish and high efficiency.

Lewiston, Mont.—G. W. Cook, President Citizens' Electric Light Co., may be addressed concerning the construction of electric-light plant.

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THE EFFECT OF ARMATURE INDUCTANCE UPON THE ELECTROMOTIVE FORCE CURVES OF AN ATERNATOR.

(Continued from page 303.)

It is also interesting to note that between no load and full load, the crest of the induction curve moves through an angle of 30°, or over one-fourth of the width of the pole faces.

The fluctuations which take place in the armature inductance are due to the changes occurring in the reluctance of the path traversed by the flux induced by the armature current. The action of the armature current is to intensify the induction in the armature core between the 60° and 130° positions of coil 1. The initial induction in the core was over 24,000 gausses when the coils were between the pole tips. The armature current acting with the field excitation maintained this saturation during the first part of the revolution and prevented any great variation in the induction in the first quadrant.

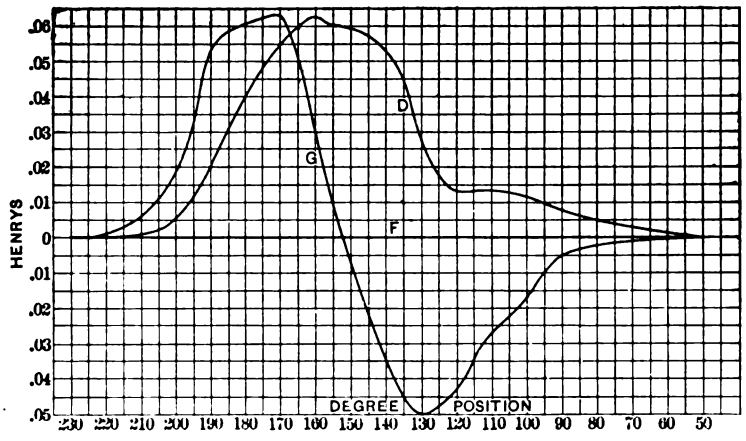

Fig. 4.

8 amperes flowing through them, they set up an induction of 18,000 gausses in the core when in the 160° position.

The great amplitude of the induction wave for 2.4 amperes in the coils is in the same way due to the fact that the permeance of the path is least when the magnetizing force is that due to this current. If we plot the values of the 140° curve of Plate 4 in terms of the armature cur-

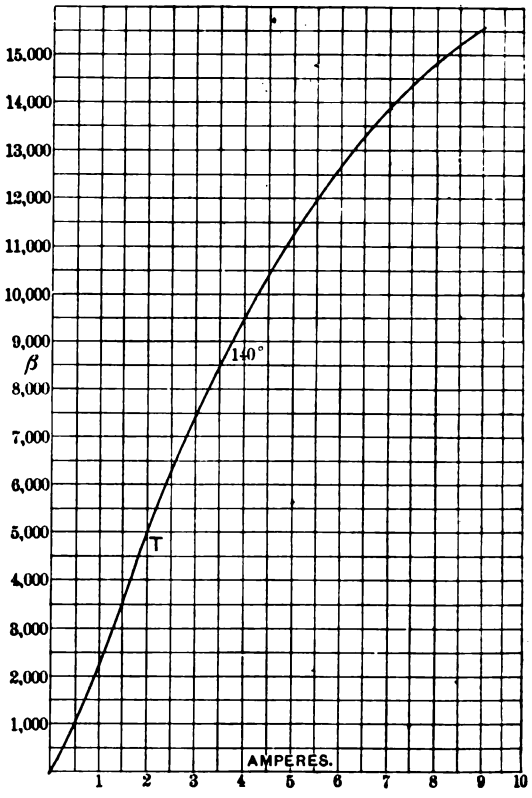

Fig. 5.

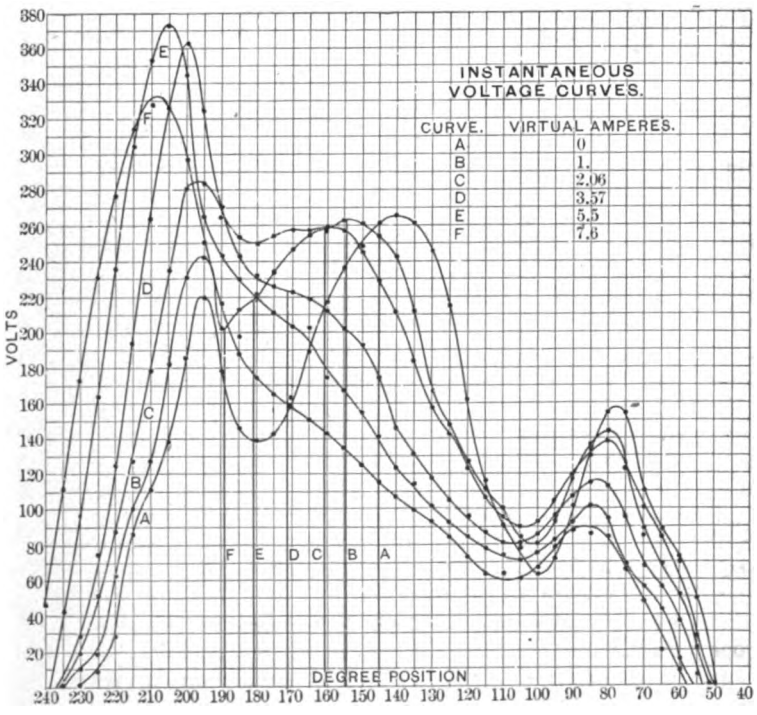

Plate 6.

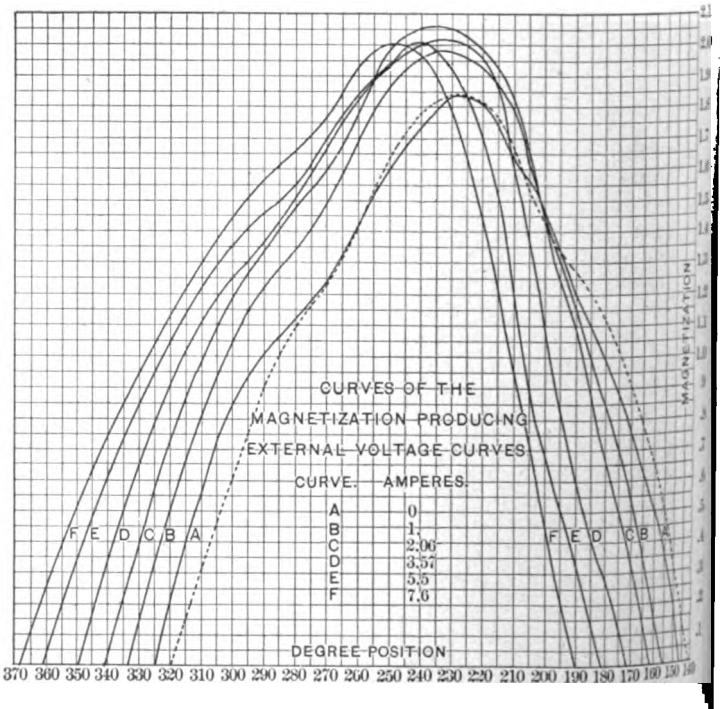

Plate 7.

But during the second and fourth quarters of each revolution, when the coils were between the 170° and 200° positions, the armature current was reacting against the field excitation, and thereby, by diminishing the flux density, was increasing the permeance of the iron and the inductance of the coils for these positions. The magnetizing power of the coils is considerable, as with

rent and the induction set up in the core by the current, we obtain the curve shown in Fig. 5. This is "Band H" curve for the magnetic circuit through the armature core in this position, and the point 'T', which corresponds to the maximum ordinate of the 140° curve, is the point where a tangent to the curve makes the greatest angle with the base line.

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The large teeth of the armature core do not seem to have the effect of causing any marked irregularities in the inductance curves. It is noticeable, however, that there is a slight hump in all of them at the 90° position. This is caused when the teeth immediately behind the coils pass the pole tips. The same effect is produced by the other teeth, but it is too slight to appreciably affect the readings.

Electromotive Force Curves.

A series of electromotive force curves taken from the machine are shown in Plate 6. These illustrate the gradual change in the wave form of the effective electromotive force as the load increases. By the effective electromotive force is meant the electromotive force that is in phase with the current and overcomes the ohmic resistance.

There is quite an appreciable lag in the effective electromotive force for the higher loads, owing to the armature inductance. This can hardly be regarded in the light of a simple phase displacement, as the lag partakes largely of the nature of a transformation of the fundamental wave A, that is due to the phase positions of the higher harmonics being shifted relatively to the fundamental harmonic, and not to any material change in the phase position of the fundamental harmonic itself. The extent of the shifting is best appreciated by noting the positions of the ordinates A, B, C, D, E and F. These lines bisect the areas of the electromotive force curves designated by corresponding letters, and indicate the points at which the induction threading the coils passes through zero and changes sign.

The curves of Plate 7 have been determined from those of Plate 6 by integrating the areas of the latter. They illustrate the waves of magnetism producing the effective electromotive force curves, and give a better idea of the extent of the lag that takes place. The scale of ordinates of Plate 7 expresses the value of the integral,

$$\int e\,dt = -N,$$

as determined from the curves of Plate 6, and must be multiplied by the constant 12,206 to express the value of the induction per sq. cm. in the iron of the armature core. The maximum induction occurring in the core is therefore a little over 25,000 gausses.* In determining the value of the constant, an allowance of 20 per cent. was made for the lamination of the iron, 80 per cent. of the gross area of the core being used as the equivalent of the iron.

Curve A of Plate 6 was obtained with zero current in the armature. This is the "fundamental" or internal electromotive force wave of the machine. It will be noticed that it is not symmetrical about the 140° ordinate. It is an irregular curve having three prominent peaks; the right hand one slightly depressed, the left hand one raised somewhat, and the central one practically symmetrical about the centre of the pole faces. The ear peaks are due to higher harmonics being superimposed upon the fundamental wave by the magnetic disturbances in the air-gap that are caused by the large teeth. Steinmetz† has noted this effect and treated the subject of the distorting influence of armature teeth in a masterly manner. His results indicate comparatively symmetrical waves for no-load conditions.

In the case under consideration, a marked shifting of the electromotive force curve in direction of rotation is caused by the teeth immediately on each side of the coils. As the teeth approach the pole tips, the lines of force do not appear to reach out to receive them to any extent. There is a sluggishness apparent. On the other hand, when the teeth are leaving the trailing pole tips, the lines of force seem to hold on with tenacity, and when they do let go, fly back with a snap as would extended strands of elastic. In the extreme cases, this action does not appear to occur until the tooth is over an inch away from the pole tips. The rapid cutting of the lines necessarily augments the potential at this point.

This explanation has its bearing upon the case, but the distortion is perhaps better explained by looking at it in the light of the part played by hysteresis and eddy currents. The eddy currents induced in the pole tips tend to oppose any change that takes place in the field distribution of the induction. They help to maintain a high induction in the trailing pole tips, and keep down the induction in the leading pole tips. The iron in the core of the armature is being carried through a complete hysteretic cycle at each revolution. The iron in the pole tips is carried through an hysteretic loop with the passage of each tooth across the pole face. At the leading pole tips the magnetism in the core iron is always working on the descending portion of the curve of hysteresis, and the reluctance of the magnetic circuit by the leading pole tips is increased accordingly. At the trailing pole tips the iron is worked on the ascending side of the hysteretic curve, and the reluctance of the path by the trailing pole tips is thereby reduced.

The same magnetizing force, therefore, acting upon the two paths, induces a distorted field when the armature is running, and a symmetrical field when the armature is at rest, as shown by curve A and the dotted curve of Plate 7. The latter curve was obtained by exploring the air-gap distribution of the flux by the ballistic method, using the exploring coil wound over coil 1, and breaking the field circuit.

(To be continued.)

INSULATION AND CONDUCTION.

(Continued from page 292.)

This paper is already so long that I cannot touch in detail on the question of cables. There are also other papers in existence written by men better equipped for the task. I had intended saying something about what Siemens has called the "absurd craze for high insulation resistance," but the fact is now generally recognized, except by inexperienced engineers, that the best cables are those of medium ohmic resistance. I will only mention two methods which have occurred to me as feasible for certain purposes. One is based on the fact that the dielectric strength of air, as shown by the experiments of J. J. Thomson and Peace, increases very rapidly with the pressure at 90 lbs. per square inch, being equal to that of a good quality of rubber. A similar plan, though not requiring a very large pressure, is due to Mr. Westinghouse, who thought of employing it four or five years ago in Philadelphia. The second occurred to the writer on reading Elihu Thomson's article on the use of liquid air as an insulator. It is this: Since ice at only 12° below freezing has a specific resistance of over 1000 meghoms, *i. e.*, as good as some brands of insulation, why not make the conductors hollow, lay them in a trench filled with water, pass cold brine through the pipes, use the brine for cooling houses, making ice, etc., and let the frozen water act as the insulator. A rough calculation shows that this is commercially feasible, even neglecting all sources of profit from the furnishing of the brine, (*i. e.*, if it were used only for cooling the pipes.) After making all allowance for friction of fluid, cost of power, etc., the balance comes at the right end, if the line is always fully loaded.

The question is sometimes raised, whether we can ever hope to have a non-inflammable substance which shall be elastic like India rubber. The probable cause of the elasticity of rubber is known,* and it would seem as if there was no reason why such a substance should not be prepared. All we have to do is to coagulate one substance in the midst of another. In fact we have at present in tetrametaphosphate of sodium such a substance, elastic as rubber, transparent and tough, and when pure a good insulator. It would be an admirable material if it were not for the fact that the elasticity is due to water, and when this dries out it becomes brittle.

As regards an organic artificial rubber, I have very

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little doubt but that it will be made as soon as it is understood by chemists that its properties are due to structural and not chemical causes.

Armature windings.—The present methods of using mica leave littie to be desired. The writer might mention, however, one novel method he used in a case where very heavy currents were to be carried. Asbestos and silicate of soda, as is well known, form a good coating, but is, however, poor mechanically. The armature bars were wrapped with asbestos string and then coated with the silicate. This made when dry an extremely firm covering which could only be removed with a hammer. Though at first a bank of 100 lamps could be lit up through the insulation, after a little running it dried out to quite a high figure and the machine did good service, at one time running several hours, as I am informed on good authority, under such an overload that the carbon brushes were red hot.

In cases where cloth is to be treated we have a very different question. There are two ways of using cloth: 1st, as a backing merely, by coating it on the surface with some substance which is supported by it, as plaster on lathing. Many substances work well in this situation, but the fact that little tubes of cellulose are very apt to stick up through the coating, as was pointed out to me by Mr. F. R. Upton many years ago, and that if moisture gets in at the edge it spreads all over, renders it not the best kind of iusulation. Rubber is sometimes applied in this way to cotton tape, but though of very high resistance and insulation at first it rapidly deteriorates. In general it should be said, that where a permanent result is desired rubber should never be used unless kept in the dark and out of contact with air. If these precautions be neglected the life is very short. The othet method is to saturate the whole cloth with some substance which will penetrate every crevice, but when this impregnating substance has solidified it must continue to fill these crevices and capillary tubes. For this reason no substance which is dissolved in anything else can be used. If, for instance, we try a varnish dissolved in alcohol, it will be found that the strength of the solution in the capillary tubes is much smaller than outside, for the same reason that sea water filtered through sand becomes fresh.* Consequently, on drying, these capillary spaces are not filled up and let water in. Therefore, unless we adopt the first method and plaster the insulator on thickly and deep enough, so that it does not matter whether the support insulates or not, we must use melted solids or drying oils. Unfortunately but few solids which melt are elastic, since this elasticity is obtained by a structure which is destroyed by melting, and those solids which melt into thin liquids and remain flexible when solid do not preserve this property except within narrow limits of temperature, as can be easily tested by holding under a cold water tap and striking the specimen sharply. Soft paraffin can be used in some cases if the cellulose be well dried and thoroughly suturated. The asphalts cannot, as a rule be used, as they never get sufficiently fluid on melting. There is, however, one notable exception: uintaite, or, as it is commercially called, gilsonite. This substance I found many years ago had the peculiar property that, when melted, like paraffin oil, it will pass into the pores of cellulose or cloth. Having a very high melting point, nearly 300° if I remember, and mixing perfectly with paraffin in all proportions, it gives mixtures which are admirably adapted for induction coil work, as these compounds can be made to have high melting points and to penetrate a coil thoroughly.

I also some years later, in 1891, used this material in combination with linseed oil for transformers, the process at first proposed being boiling in vacuum, but it was found that, even without this, saturation was complete. I understand that this method is still used, though modified in form, by the company for which I first devised it. Of the drying oils, with the exception of some foreign oils as Chinese wood oil, and an African oil whose name I cannot recollect or ascertain, linseed and the drying nut oils are the best. Linseed oil has the remarkable property of expanding on drying. This enables it to fill up all pores. Its durability is evinced by the good condition of old oil paintings. The varnishes crack and go, but the oil remains.

Its insulation is not injured up to very high temperatures at which shellac, rubber, etc., would be worthless. This material was used a great deal by the Edison company in its early days, but it often broke down. The trouble was traced to the lead drier, and after many experiments Mr. Marshall, who had charge of this work, finally settled upon the use of pure raw oil. This gave excellent results and was long used but took some time to dry, and the writer finally, after many tests, found that borate of manganese drier got rid of the trouble, while, as is well known, it gives a very quick drying varnish. This was used by the United States Company in Newark on their machines, with the result that in 1890 after use for a year, the foreman reported only two armatures so treated as returned for repair (they were injured by lightning), and no fields. This material was also used by the Stanley Company for transformers.

Another advantage of this borated oil is that it always retains a slight stickiness, and so gives a good joint when wrapping around wires, etc. Many substances so used are not sticky and let moisture in through the joints. Where a smooth surface is required, it is readily obtained by dusting on a little talc, a method first suggested, I believe, by Mr. Edison. It can also be given a coat of Japan on the outside. Varnish gums should never be used with linseed oil, as they are brittle, and the dried oil is only just flexible enough. Consequently when the oil has dried the resultant varnish is always very brittle. A temporary elasticity is given at first by the fact that when the solvent has dried off the oil is still fluid and undried, and as the varnish gum keeps the air from getting at it rapidly, it sometimes remains flexible for a year. Such mixtures also crack when cold.

(To be continued.)

MR. S. MARSH YOUNG, vice-president and general manager of the Manhattan General Construction Co., 11 Broadway, New York, will be at the Auditorium Hotel in Chicago during the convention of the National Light Association with a full line of the new Manhattan Enclosed Arc Lamps. These lamps are designed to burn in multiple on circuits of from 90 to 250 volts, and two or more in series on circuits of from 200 to 600 volts, and on alternating-current circuits of from 90 to 130 volts and any number of alternations.

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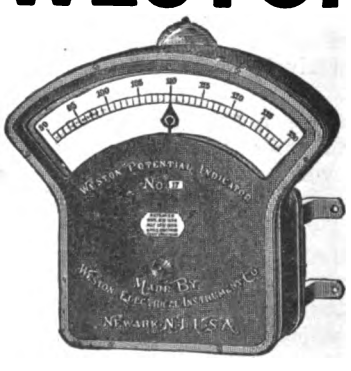

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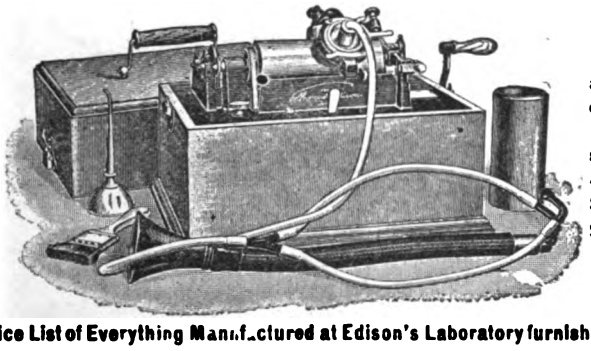

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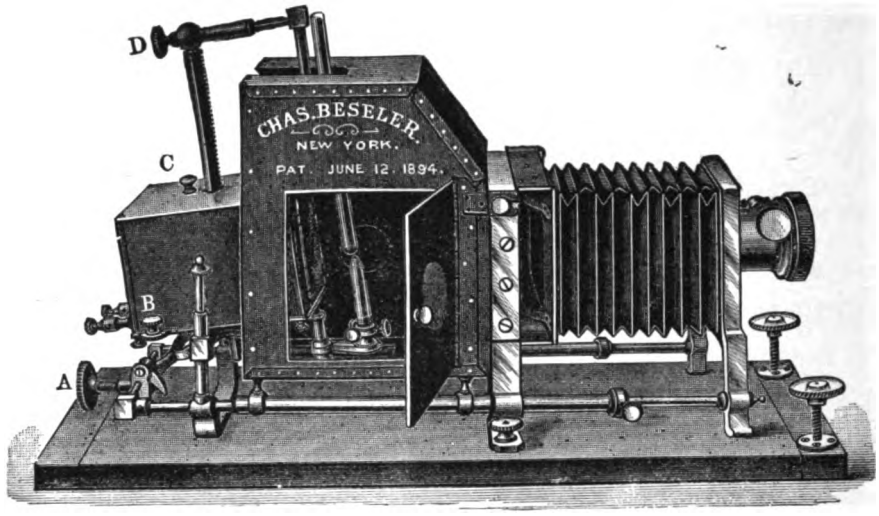

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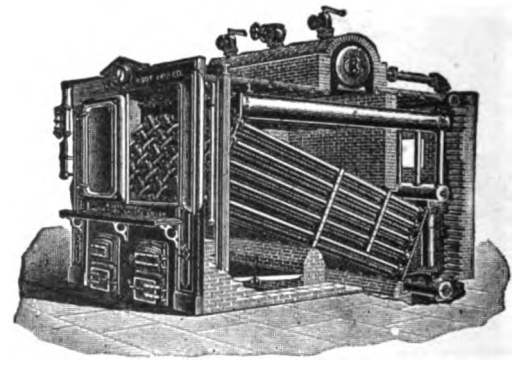

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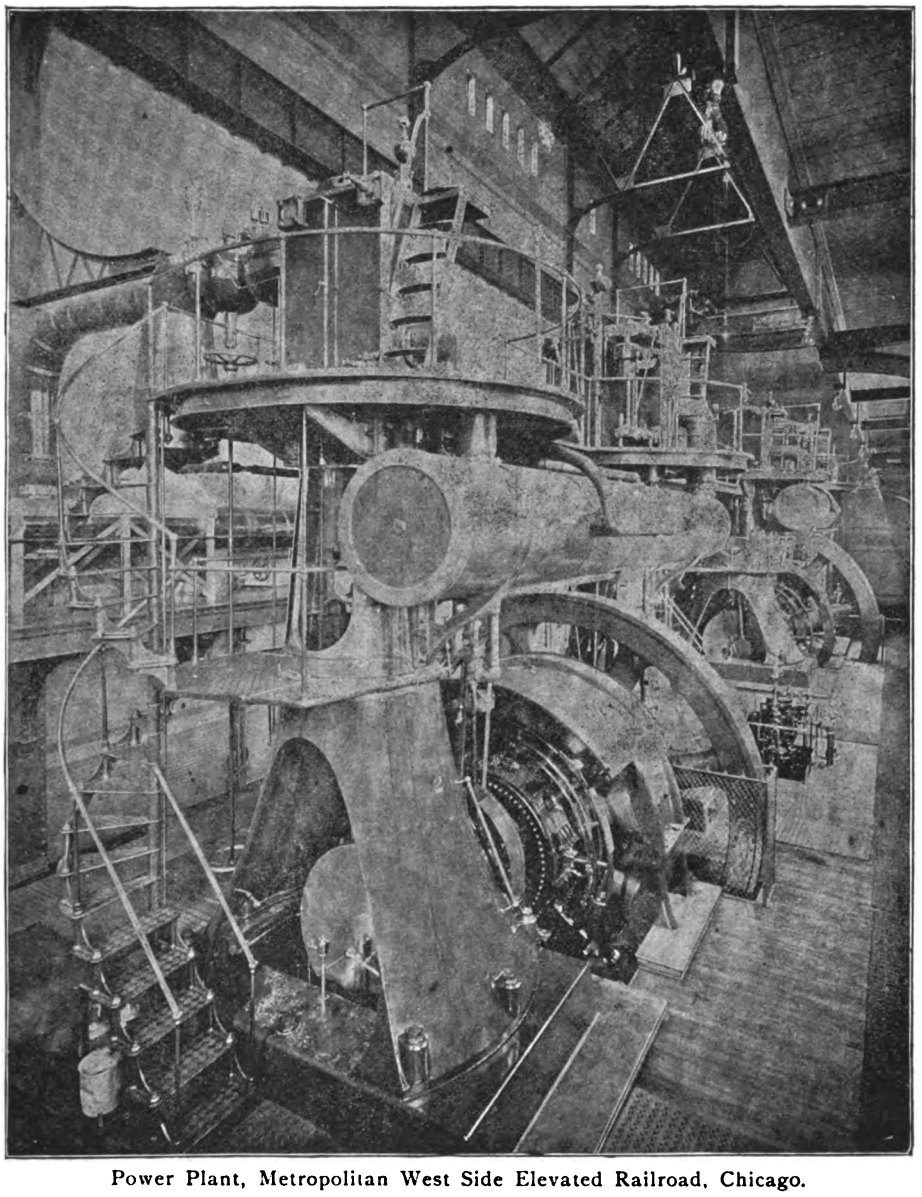
VOL. XXI—No. 24 NEW YORK, JUNE 11, 1898 WHOLE No. 578



Power Plant, Metropolitan West Side Elevated Railroad, Chicago.

THE METROPOLITAN ELEVATED RAILROAD OF CHICAGO.

The Metropolitan Elevated Railroad of Chicago was opened to the public on April 17th, 1895, although regular traffic did not begin until May 1st. Starting from the lake front and leaving the more densely populated business centre, the road branches off in every direction. The total length of the road, including branches and trunk line, is about twenty miles.

The main line starts on Franklin street. It has four elevated tracks, and is 1.81 miles in length. From Paulina street the Garfield Park and Logan Square branches diverge, and the Humboldt Park line is a branch of the Logan Square line. The Douglas Park line runs south from the Paulina street terminus of the main line westward for a distance of 3.7 miles. Each of the branches has two tracks.

The road runs through the centre of the blocks, thus only crossing streets instead of traversing their length. The company acquired the land by direct purchase, partly through condemnation proceedings, and much of the way was cleared by the destruction of buildings.

The stations are all built under the tracks, stairways leading to the track platforms.

One car of each train will be the traction car, and will take the current from a special rail laid on the deck of the road. The electric system is that of the General Electric Company.

A view of the generating station of the Metropolitan road is reproduced herewith from the "Scientific American." The generators, as will be seen, are of the multipolar type, and are driven direct.

One type of generator driven at 75 revolutions per minute maintains a voltage of 500 on no load and 600 loaded, with a current of 2,230 amperes. Another type at 100 revolutions gives 500 volts with no load and 550 volts with full load, and a current of 1,450 amperes. The armature winding consists of heavy bars of copper insulated by mica. They were wound when in place. There are twelve field magnets in the circle inclosing each armature. It was only after the winding of the armature and setting up of the field around it that the engines were assembled. The engines are Allis Corliss, and are compound inverted vertical, direct-acting, standing some 50 feet high, with 25-foot fly-wheels. There are five; two are of 2,500 horsepower each, the others of 1,000 horse power each. The dynamo comes between the high and low pressure sides, so as to be inclosed by the engine frames. It is claimed

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that the energy stored up by the fly-wheel at full speed is enough to run a train of cars from the power house into the city. A Morgan electric crane of 75 tons capacity, also shown in the illustration, spans the engine house, commanding the entire area.

The massive switches are mounted on a white marble base plate. The current from the power house goes to the car motors by the lateral contact rail and returns by the regular rails to the station. Each traction car will carry four motors, so that maximum efficiency will be given at three different speeds. On starting, the motors are thrown into series; at the next speed two are in parallel and two in series, and at the highest speed all are in parallel. Air brakes will be used, a small motor working the air pump on the motor car.

The steam is generated in 16 Babcock & Wilcox boilers, provided with automatic stokers. The plant is so designed as to admit of future enlargement without disturbing existing conditions. It is located on an alley back of Throop street, between Van Buren and Congress streets.

The motor cars were built expressly for this service by the Barney & Smith Car Company, Dayton, Ohio. Each car, without its electrical apparatus, weighs nearly 40,000 pounds, is 40 feet long in body, and 47 feet 3 inches over all. There is a motorman's cab at each end, which takes up a portion of the platform space.

The trains are lighted by electricity.

The Logan Square line is carried over the tracks of the Northwestern Railroad on a bridge with a 250-feet span. Besides this bridge there are other fine examples of engineering skill.

It seems likely that the success this road has already met with will induce the proprietors of the Manhattan Road of this city to instal a plant of a similar nature. The simplicity of the system, its economy of operation and low rate of depreciation will certainly assist in bringing about this desired result.

INSULATION AND CONDUCTION.

(Continued from page 320.)

Sample C is a specimen of borated oil saturated cloth, which is now between eight and nine years old. It will be noted that it is still fresh and flexible, and a recent dielectric strength test showed up very high, 7000 volts, if I recollect. The pure raw oil is boiled at about 200° with ½ per cent. of borate of manganese for several hours till it begins to be thick.

Non-inflammable materials can be made as I have pointed out elsewhere, by taking out the hydrogen atoms of hydrocarbons and substituting chlorine. Even paraffin can be thus treated if kept warm, and first turns to a fluid and then to a solid. At one time it seemed as if this process might be valuable, but the use of enclosed conduits has done away with the greatest source of danger from fire.

I will conclude by describing a couple of devices which I have found useful in preventing insulation from being spoiled. Soldering acid, as commonly used, is a solution of chloride of zinc. If this falls on cellulose it turns it to a paste. It never evaporates and always takes up moisture from the air, and will gradually eat its way through quite a thickness of insulation. Whether it is acid or neutral makes no difference so far as its action on the insulation is concerned, though the neutral solution does not corrode the wire. Rosin has the disadvantage that it is not a fluid and is clumsy to handle. I have found that by shaking up powdered rosin in very strong ammonia, an ammonia soap is produced which works well in most cases. The ammonia dissolves the copper oxide and evaporates afterwards, leaving the powdered rosin, which is an insulator.

Apparatus can be protected from overheating by putting in the apparatus a small glass tube filled with carnauba wax. This melts near the danger point, but remains quite hard up till then, so that by imbedding a spring and contact in the wax, when the apparatus gets too warm the wax gives, and the spring expanding causes a short circuit which blows the fuse.

The largeness of the subject must be my excuse for the fragmentary nature of this paper. After I had begun it I found I had made a mistake; what I should have undertaken was to write a book. I trust, however, that some of the points I have developed may prove of interest.

* Popularly known as the Tesla coil, on account of his having brought it into prominence through his use of it in his lectures; though it was invented and first described by Elihu Thomson.

† Elec. World, Aug. 8 and 22, 1891.

‡ Phil. Mag., Dec., 1892.

* Molecular Physics, Franklin Inst., Sept., 1896.

† J. J. Thomson, "App. on Dyn. to Phys. and Chem.," p 190.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. *

At a recent meeting of the Institute held at 12 West 31st street, New York, a paper was presented by Prof. R. A. Fessenden on "Insulation and Conduction," just concluded on this page. About seventy-five members and guests were present, with President Crocker in the chair.

In the absence of the author the paper was read by Mr. R. W. Ryan and discussed by Prof. Franklin and Dr. Pupin.

The secretary announced that at the meeting of the council in the afternoon the following nominees had been selected from the proposals submitted by the membership: For President, Arthur E. Kennelly. For Vice-Presidents, Robert B. Owens, William Stanley, Cary T. Hutchinson. For Managers, Herbert Lloyd, Samuel Sheldon, Geo. F. Sever, Chas. P. Steinmetz. For Treasurer, Geo. A. Hamilton. For Secretary, Ralph W. Pope.

The following officers continue their terms as provided in the constitution: Vice-Presidents A. E. Kennelly, Chas. S. Bradley, D. C. Jackson. Managers J. W. Lieb, Jr., F. A. Pickernell, W. L. Puffer, L. B. Stillwell, Alexander Macfarlane, W. F. C Hasson, Gano S. Dunn, Herbert Laws Webb.

The question of standardization of electrical machinery was referred to a special committee composed of Elihu Thomson, Francis B. Crocker, A. E. Kennelly, C. P. Steinmetz, C. T. Hutchinson, J. W. Lieb, Jr., L. B. Stillwell.

The following associate members were elected: Albert G. Davis, acting manager, patent dep't, General Electric Co., Schenectady, N. Y.

Albert R. Gallatin, student at Columbia University, residence 58 West 55th street, New York City.

Herbert Gaytes, electrical engineer, Realty Syndicate Railways, Piedmont Power House, Oakland, Cal.

Griffin Russell Agnew, purchasing agent, American Telephone & Telegraph Co., 15 Dey street, New York City.

Francis Valentine T. Lee, engineer (Pacific Coast Dep't), Stanley Electric M'f'g Co., 300 California street, San Francisco, Cal.

Max Loewenthal, associate editor, The Electrical Engineer; residence, 831 Park avenue, New York City.

Henry W. Pope, special agent, American Telephone & Telegraph Co., residence, 200 West 83d street, New York City.

Fritz Reichmann, instructor of Physics, The University of Texas, 309 East 11th street, Austin, Tex.

Theodore E. Theberath, Pacific Coast engineer, Stanley Electric M'f'g Co., 300 California street, San Francisco, Cal.

Robert Anton Fliess, student of electrical engineering,

* 26 Cortlandt street, New York City, March 24th, 1898.

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Columbia University; residence, 201 West 55th street, New York City.

The opening date of the general meeting at Omaha was fixed for June 27th, and its continuation for either three or four days has been left with the Committee on Papers and Meetings for decision. Ralph W. Pope.

EFFECT OF ARMATURE INDUCTANCE UPON THE ELECTRO-MOTIVE FORCE CURVES OF AN ALTERNATOR.

(Continued from page 319.)

The activity displayed by the eddy currents in heating up the pole tips is quite remarkable. The curves B and A of Plate 8 indicate the rise in temperature of the leading and trailing tips, respectively, throughout a two hours' run. The readings were taken from thermometers fastened directly to the pole pieces. The curve C is a curve of differences derived from curves A and B, and it indicates how very much more rapidly than the temperature of the leading pole tips the temperature of the trailing pole tips rises during the first twenty minutes of the run. Their difference in temperature after that time is practically constant. The curves plainly indicate that much greater magnetic disturbances occur in the leading pole tips than at other points in the pole faces. The thermometers had to be fastened to the back of the pole tips during the test; had it been possible to connect them in contact with the air-gap face, more rapid changes would doubtless have been recorded.

During the test the field coils were excited with a current of 10 amperes, and the armature was loaded to about 5 amperes. At the end of the run the temperature of the armature was 42° C.

As the armature core has sixteen teeth, or four per pole face, we may expect harmonics as high as the ninth to play a prominent part in the wave structure.‡ The general form of the internal electromotive force curve A is indicative of the fifth harmonic; the side peaks have been sharpened, however, by the upper harmonics, and the central one somewhat broadened by the third.

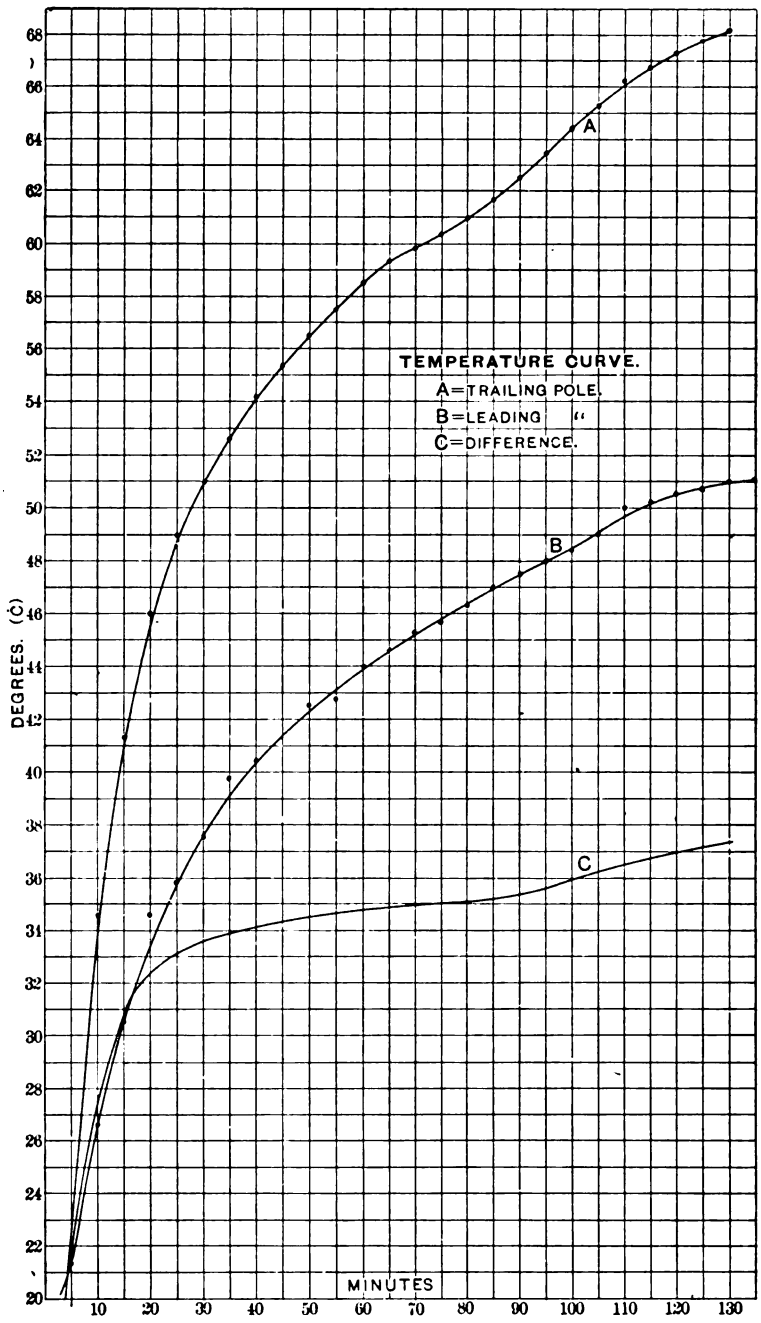

Plate 8.

The wave form of the electromotive force induced in the armature when the machine is loaded depends upon the character of the inductance curve of the armature coils. As already explained, the effect of the teeth upon

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the inductance curves is to introduce harmonics and cause irregularities in their contours. Practically the same number of harmonics are prominent in all the electromotive force curves, although the armature inductance has the effect of smoothing out the irregularities by giving the third harmonic greater prominence and diminishing the effect of the higher harmonics. As the current rises and the magnetizing power of the armature becomes apparent, the harmonics introduced into the circuit by the variable inductance grow in amplitude. They combine with the harmonics of like order of the fundamental wave, and an electromotive force curve results that is compounded of a series of harmonics that depend upon the value of the armature current for their amplitude and phase positions.

The electromotive force and current waves can be attributed to the cyclic variations in the inductance of the system, and when these are known within a fair degree of approximation the character of the wave modifications that will result can be determined.

In the development of the experimental results contained in this paper the dynamo was loaded by inserting sets of incandescent lamps in the external circuit. A special point was made of keeping the external circuit entirely free of any inductance. The current curves are therefore necessarily proportional to the electromotive force curves. However, to make their relative value and form more easy of appreciation, they have been plotted and are shown in Plate 9. The inductance curves of the coils that correspond to the alternating current curves

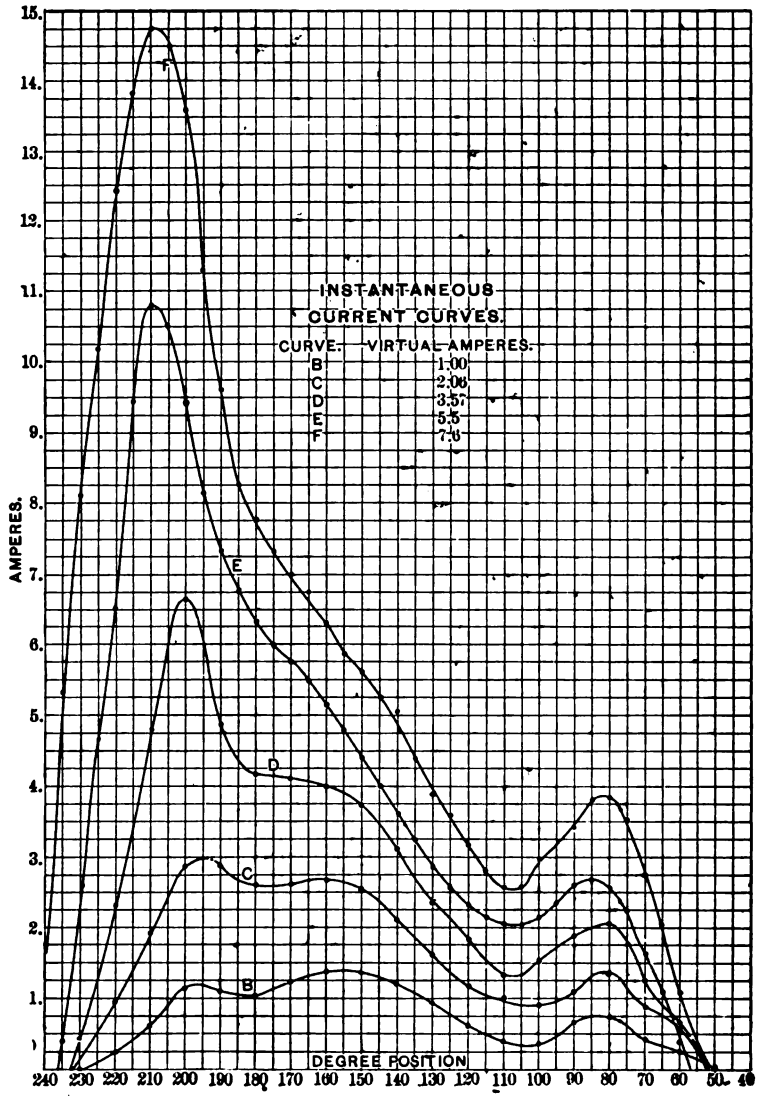

Plate 9.

A very small amount, if any, of the change in the form of the effective electromotive force waves is due to any departure of the original no-load wave of field flux from its initial wave form. In fact, to all practical intents and purposes the pulsations that occur in the magnetic reluctance of the field circuit are sensibly of the same intensity at full load as they are at no load. In other words, the changes that occur in the permeance of the core of the armature as the load varies do not appreciably alter the permeance of the field circuit. The fundamental wave of magnetism and of electromotive force may therefore be regarded as always being present, if not always tangible.

When alternating current generators are operated on circuits having a constant resistance for constant conditions of load, the disturbances that modify the form of are given in Plate 10. These curves were determined by selecting from the curves of Plates 4 and 5 inductance values corresponding to the instantaneous values of the current curves and plotting them to same degree positions.

It is noticeable, owing to the different scales used in plotting the curves, that the current curves seem more even and smoother than the electromotive force curves. The inductance curves also are more nearly alike, both in phase and in amplitude, than the curves of Plate 3. This is owing to the fact that the alternating currents all start from and end at zero values when the coils are in positions of slight inductance, while they attain their maximum values at points of large inductance. For this reason the average inductance per cycle of the coils is greater with an alternating current flowing in them than with a direct current of the same effective value.

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The alternating currents, for analogous reasons, force the induction curves up to the saturation limit marked by curve G of Plate 3 more rapidly than do the direct currents, and therefore for the same variation in effective current strength a less marked variation is caused in the inductance curves with these currents. The curves of Plate 3 certainly lead us to expect a greater variation, relatively to current intensity, in the armature inductance when the armature is in actual operation than that which is depicted in Plate 10.

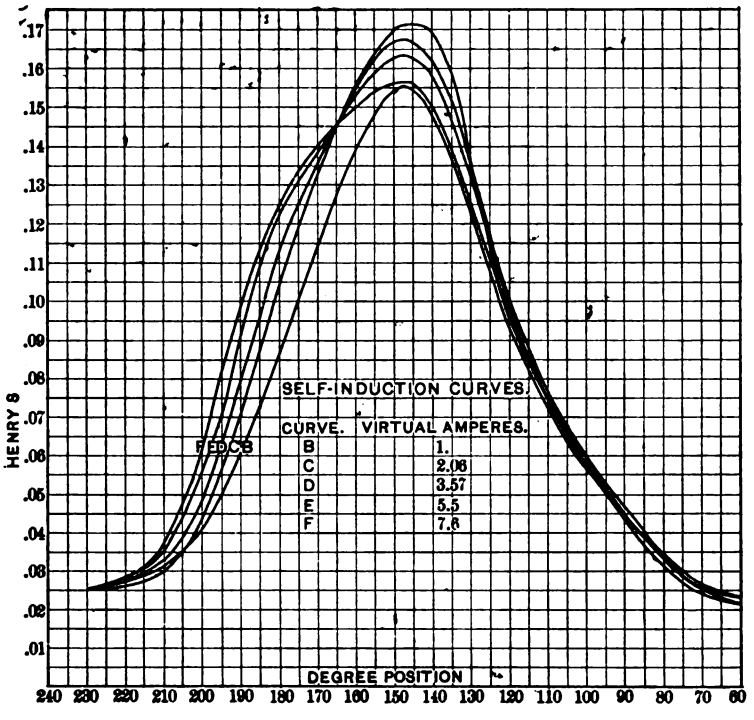

Plate 10.

It is a curious coincidence that the alternating current inductance curves all cross at a common point, namely, at the 164° position.

(To be continued.)

LIVE WIRES AT THIS WEDDING.

Charles Sanford Merten, of No. 343 Forest avenue, Bronx, and Miss Jennie S. Gilmour, of No. 38 India street, Brooklyn, were married by a minister in the Moore Chapel of the Electrical Show, Madison Square Garden.

Both bridal parties went to the wedding in electrical carriages. The little chapel, which was built to show the "daylight system" of lighting, was illuminated from tubes that curved over the ceilings. R. McFarland Moore, the inventor of the system, officiated.

The Mendelssohn and Lohengrin wedding marches were played on a pipe organ run by an electric motor.

JUDGE ADAM E. SCHATZ, of New York City, has recently received valuable Canadian patents on his system of canal hauling, described in the Christmas Number of the "Electrical Age." Extremely favorable comments have been made by European as well as American journals, as well as a technical nature. A full illustrated article appears in "Le Courrier de la Presse," of Paris.

* Some elaborate tests were made on Brush dynamos in 1889 by Mr. Murry. The values of B attained were about 4,800 gausses in the field and 27,000 in the armature cores. See S. P. Thompson's "Dynamo Electric Machinery," p. 464, 1892 edition.

† C. P. Steinmetz, Transactions, vol. xii., p. 470.

‡ C. P. Steinmetz, Transactions, vol. xii., p. 475.

NEW YORK ELECTRICAL SOCIETY.

Tne annual dinner of the New York Electrical Society was enjoyed by one hundred and fifty members and guests on Friday night, May 27th. The dinner was given at the St. Denis Hotel and proved to be a success from a gastronomic and social standpoint. The decorations were very pretty and the music charming. Speeches were made by the following gentlemen: New York Electrical Society, President Gano S. Dunn; the secretary, Mr. G. H. Guy, entertained the guests with some classical selections in music instead of expressing his feelings with a burst of rhetoric. The American Institute of Electrical Engineers was dilated upon by Prof. F. B. Crocker; the technical colleges by Mr. Joseph Wetzler; the Yankee Militant, Capt. F. L. Zalinski, U. S. A.; Sister Societies, Dr. W. McMuetrie; the Newspaper Man, Mr. S. L. Coles; Electrical Applications, Mr. F. W. Jones, the original president of the society in 1881; the Electrical Manufacturer, Mr. H. Ward Leonard; What We Think of Electrical Engineering, Messrs. C. O. Mailloux and H. B. Coho. Both spoke from different standpoints; one from that of the consulting engineer; the other that of the electrical contractor. The evening wound up with a great deal of good fellowship on all sides and a feeling that the New York Electrical Society occupied a place of great importance in the opinion of American electrical engineers.

At the recent election Thursday evening, held at the Electrical Exhibition, Gano S. Dunn was elected president; W. E. Case, H. B. Coho, Dr. C. A. Doremus, F. A. Patterson, E. E. Higgins and Chas. Blizard, vice presidents; Geo. H. Guy, secretary, and Henry A. Sinclair, treasurer.

A representative of the "Electrical Age" recently spoke over the wires a distance of twelve hundred miles by telephone. The conversation was held between New York City and Fort Wayne, Indiana. The speech was perfectly clear and distinct in every particular and shows how well perfected long distance telephony has become. This telephone line is made of pure copper. The line insulation is unusually high and the pole work has been completed in the most careful manner. It is hard to realize

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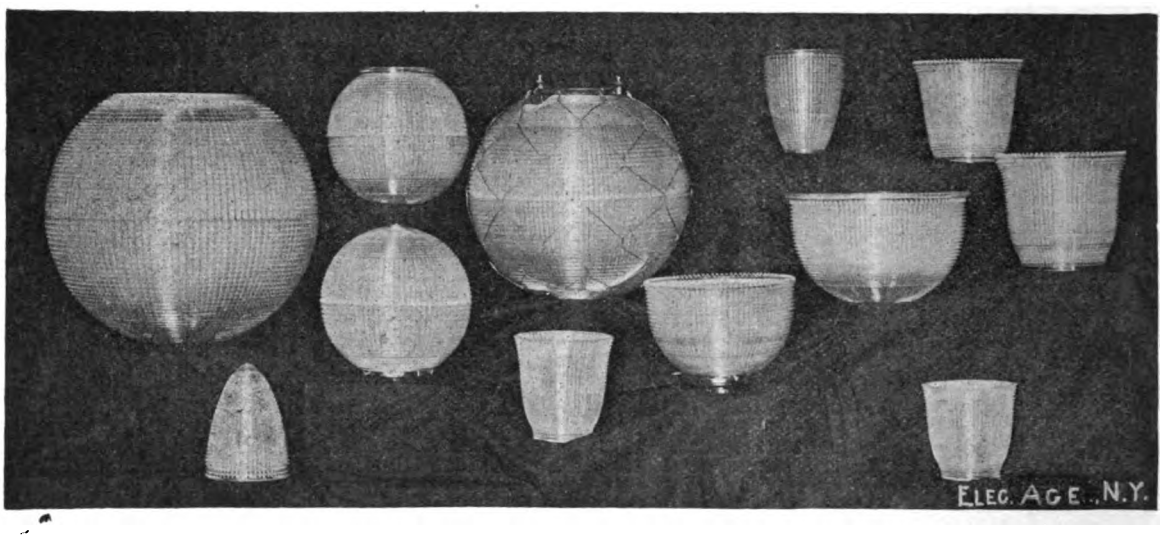
that more than a thousand miles separates you from your auditor, the syllables and annunciation are so perfect. Mr. Edward J. Hall is vice-president and general manager of the American Telephone and Telegraph Company, and is to be congratulated upon the success of his efforts in furthering long distance telephony. He and his staff of engineers have proven conclusively that telephoning is perfectly practical over long distances, and we would not be surprised to hear of the existence of a line that wedded the Atlantic with the Pacific Ocean, and brought into the closest communication the metroplis of the East and the far West.

THE EFFICIENT DISTRIBUTION OF LIGHT.

Light is produced today in a most expensive manner. Scientific tables will show that more than ninety-five per cent. of the fuel used for the production of electric, gas or oil light, is absolutely wasted. If this is the case and we then discover that in the process of distributing the light about twenty-five to fifty per cent. is again lost in the majority of cases, a necessity for the proper distribution of light is most pronounced. The use of globes and shades and other paraphernalia for surrounding a light-giving source received very little attention until Messrs. Blondel and Psaroudaki, making a scientific study of the problem, invented the famous "Holophane" globe. The Franklin Institute of the State of Pennsylvania, in their favorable criticism of the "Holophane" globe, state as their belief that it secures much better diffusion and more satisfactory distribution than any other globe known to its members. It is quite evident from these remarks that the diffusion and distribution of artificial light is most successfully secured by means of these most remarkable globes. On November 3, 1897, the Franklin Institute recommended the award of the John Scott Legacy Medal and Premium to the two inventors, Messrs. Blondel and Psaroudaki. The Holophane Glass Company, of 1 Broadway, New York City, manufacture and sell "Holophane" globes of the most efficient construction. Their samples are on hand for examination by all sufficiently interested to call.



Holophanes.

The second preliminary announcement of train service and through cars via "America's Greatest Railroad," New York Central & Hudson River R. R., has just been issued by Edgar Van Etten, General Superintendent, and George H. Daniels, General Passenger Agent, Grand Central Station, New York.

Concord, Mass.—Work on the proposed electric-light plant is expected to commence shortly.

MEMBERS NEWLY ELECTED TO THE NEW YORK ELECTRICAL SOCIETY.

W. C. Broadhurst, 120 Broadway, 4th floor, Room 25, N. Y.
H. M. Lamont, 120 Broadway, 4th floor, Room 25, N. Y.
C. Morris Haskell, 27 Morris place, Bloomfield, N. J.
Edwin H. Daly, 1064 Madison avenue, N. Y.
Gustavo Lobo, 219 W. 44th street, N. Y.
Richard Lamb, 1 Broadway, N. Y.
J. B. Taltavall, 253 Broadway, N. Y.
Fred Catlin, 253 Broadway, N. Y.
Clarence W. Phillips, 1420 Fifth avenue, N. Y.
Marcus Nathan, 15 Cortlandt street, N. Y.
Harris I. Goldstein, 79 Clinton street, N. Y.
A. L. Saruya, Saruya Eng. Co., 32 Park place, N. Y.
Joseph Miller, 216 Madison street, N. Y.
Henry C. Mortimer. Jr., 54 W. 21st street, N. Y.
Earle Ovington, 39 W. 26th street, N. Y.
Dr. C. A. Doremus, 59 W. 51st street, N. Y.
Geo. F. Porter, 203 Broadway, N. Y.
A. L. Doremus, Crocker-Wheeler Elec. Co., 39 Cortlandt street, F. Y.
Horton Webster Haddock, 1 W. 129th street, N. Y.
Richard Koch, 47 E. 78th street, N. Y.
H. A. Strauss, 120 Liberty street, N. Y.
F. M. Hawkins, 39 Dey street, N. Y.
Conrad Watchter, 55 S. 4th avenue, Mt. Vernon, N. Y.
Elmer P. Morris, 15 Cortlandt street, N. Y.
John Maguire, 371 Fulton street, Brooklyn, N. Y.
John Joyce, 129 Huron street, Brooklyn, N. Y.
Jens Skougaard, The Dakota, 72nd street, N. Y.
E. Y. Porter, Iron Clad Rheostat Co., Westfield, N. J.
C. D. Warner, Newark, N. J.
S. Glover Way, 34 W. 35th street, N. Y.
Harold Briesen, Weehawken, N. J.
Christopher M. Lowther, 36 Riverside Drive, N. Y.
W. J. Clarke, 141 E. 25th street, N. Y.
R. E. Gallaher, 15 Cortlandt street, N. Y.
E. N. Stevenson, 15 Cortlandt street, N. Y.
Theo. B. Entz, Storage Battery Co., 20 Broad street, N. Y.
W. H. Palmer, Storage Battery Co., 20 Broad street, N. Y.
Wm. F. Crawford, Blackall & Baldwin, 39 Cortlandt street. N. Y.
C. N. Wheeler, Crocker-Wheeler Elec. Co., Newark, N. J.
C. W. MacMullen, 42 E. 23rd street, N. Y.
C. M. Clark, 42 E. 23rd street, N. Y.
Jos. C. Youenes, 100 W. 105th street, N. Y.

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NEWTON HARRISON, E. E., Sec'y, Treas. and Editor.

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THE DESTRUCTION OF LARGE BUILDINGS BY ELECTROLYSIS.

With each advancing stage of civilization there arise new complications so closely interwoven and so inimical in many cases to personal safety and happiness that it seems as though civilization were better off freed from such evils. Since the advent of the trolley certain cries have arisen from the municipality; bridge builders over whose structures the electric road passes; and, finally, from the architect and builder. It appears that the owners of those buildings constructed with a metal framework fear the dangers of electrolysis. They complain of the steady undermining going on in the very foundations, and believe with a palsied fear that the huge monoliths will some day weaken at their base to such an extent that the building will be unsafe and consequently untenantable. In the columns of "Architecture and Building," of New York, the subject has been discussed in relation to Chicago's skyscrapers with the conclusion, to quote the writer, as follows: "while this danger has been hinted at before the discussions that have appeared from time to time as to the dangers from rust and corrosion to the metal structures of the skyscrapers, little attention has been paid to electrolysis affecting foundations.

From the above it will be seen that engineers and architects have a serious problem to work out in protecting their buildings against this danger. Apparently the remedy is insulation or the adoption of other than metal for the underground work where dampness is certain to be present and render iron subject to electrolysis."

We are of the opinion that the dangers arising from electrolysis are not as great as depicted by the active pen of this writer. When considering the matter from a purely theoretical standpoint the idea that by continued electrolytic action iron foundations will be torn away piecemeal until the building rests upon uncertain and weakening supports is horrifying to contemplate, but from a practical standpoint the conclusion may be reached that the leakages of current have so great an area to affect that each building individually is subjected to but little of its deleterious influence, and consequently the dangers of electrolysis pass away as a delusion unfounded by experience and unsubstantiated in daily practice. It is unfortunate, however, to realize that when electrolysis does occur the blame must be laid at the door of the street-railroad corporation. The electrical energy sent through its lines and tracks will, unless the proper return is supplied, take whatever metal work is in the vicinity as a means of completing its circuit. It is therefore evident that a lack of feeders along the line of the trolley will inevitably give rise to the unfortunate conditions discussed so freely by the daily papers and some technical journals.

Can there be some inter-relation between electricity and magnetism? The first positive answer seems to have been given by Romagnesi in a work published in 1805, but little or no notice appears to have been taken of this. Certainly no progress was made in the subject till 1820, when Oersted made his famous experiment before his class. By that experiment he proved that a wire carrying an electric current will, when properly placed, deflect a magnetic needle. The subject was almost immediately taken up by Ampere, and in a few months many of the important consequences which Oersted's discovery involved were developed. Ampere's work on the action of currents on currents and on magnets is classical and is still treated as part of the fundamental basis for the theory of electrodynamics. An account of his work may, therefore, be found in almost any of the numerous text-books on electricity. The conclusions reached by Ampere were confirmed by Weber by a series of much more refined experiments. To Weber also we owe improvements in galvanometers. The same year marks the discovery by Arago that a current cannot not only deflect a magnet, but that it is capable of producing one by magnetizing steel needles.

The further discovery was made four years later by Sturgeon that soft iron, although incapable of making a strong permanent magnet, is yet much more susceptible to temporary magnetization by the electric current. Arago also made about this time the important discovery that if a needle be suspended above a copper disk and the disk rotated, the needle will be dragged round with the disk. This was not explained for some years, but seems to be the first discovery of induced currents.—Prof. Thomas Gray.

LITERARY NOTE.

One by one the magazines drift to New York. Now it is The Home Magazine which begins its metropolitan existence with the June number. New York is the literary centre of the country, so we suppose it is but natural that all the publishing interest should centre there.

The Trow Press will do the work on the Home Magazine. The editorial offices will be located in the St. James Building, Broadway and 26th street.

And by the way, the May issue, the last gotten out in Binghamton, is a splendid example of mechanical work. It is a most readable book, too; there are a number of timely illustrated articles, many short stories, special articles, etc., making it all in all a delightful number.

Greenwood, S. C.—Walton & Wagner, Rome, Ga., have received contract for establishing waterworks, and The General Electric Co. has received contract for installing electric-light plant.

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Calvin Winsor Rice, P. O. Box 774, Brooklyn, N. Y.
L. B. Pearson, 82 Morningside avenue, N. Y.
Fenton S. Grant, 148 Ninth ave., N. Y.
Philip Menges, 451 W. 48th street, N. Y.
D. L. Collins, 50 Dey street, City.
Louis S. Levy, 687 E. 139th street, N. Y.
Samuel F. Butterworth, Edison Elec. Ill. Co., 117 W. 58th street, N. Y.
J. J. Bellman, Crocker-Wheeler Elec. Co., Newark, N. J.
Geo. Sanders Weston (2nd), 476 W. 143rd street, N. Y.

DEVELOPMENT OF ELECTRICAL SCIENCE.

(Continued from Page 298.)

The work of Planté and of Faure and others on secondary batteries has been of great value commercially. They gave rise to severe chemical problems, but the main difficulty here also has been of a mechanical kind, and they have not added much to the knowledge of electrical laws.

The transformation of alternating currents from high to low potential and vice versa, by means of what are commonly called transformers, has shown another remarkable development of Faraday's discovery of induced currents. The application of transformers has made it possible to distribute electrical energy over large areas in a moderately economical manner, and incidentally has led to a considerable increase in the knowledge of the magnetic properties of iron.

One of the most important of the applications of electricity is that of electro-chemistry. The chemical action of the electric spark was noticed by van Groest and Dieman in 1739 in the decomposition of water. Beccari, about the middle of the 18th century, obtained metals from oxides through which the spark had passed, and in 1778 Priestley noted the production of an acid gas when the electric spark was passed through air. Similar experiments were made by Cavendish and Van Marum on decomposed ammonia. It is not, however, until after the discovery of the voltaic cell that the subject of electrolysis really begins. I have already referred to the discovery of Nicholson and Carlisle in 1800, and the subsequent work of Davy and of Faraday. The peculiar phenomenon of the appearance of separated elements only at the end plates in the electrolytic cell led to considerable speculation, and was explained by Grothuss on the supposition that the molecules separated into two parts, one positively and the other negatively electrified, and that these parts formed a chain between the plates along which chemical action traveled by a continual interchange of mates, the end parts going to the plates. This theory was held for many years, and is still to be found in some text-books. Faraday's work is by far the most valuable of the early contributions to the subject. He gave the following laws:

The amount of chemical decomposition in electrolysis is proportional to the current and the time of its action.

The mass of an ion liberated by a definite quantity of electricity is directly proportional to its chemical equivalent weight.

The quantity of electricity which is required to decompose a certain amount of an electrolyte is equal to the quantity which would be produced by recombining the separated ions in a battery.

These laws are all of the greatest importance, and the last one clearly points out the reversibility of the electrical process. By forcing a current through an electrolyte it is decomposed and the mutual potential energy of the components consequently increased. By allowing the components to recombine in a battery the mutual potential energy is reduced and a current of electricity is the result. An excellent illustration of this action is exhibited by the secondary battery.

In 1857 Clausius gave a theory of electrolysis and at the same time reviewed the weaknesses of the hypotheses of Grothuss and others. Clausius assumes that the molecules of the liquid are in continual motion; that impacts frequently occur which produce temporary dissociation, leaving atomic groups charged with opposite electricities, and that during these separations any directive agency, such as an E. M. F., is able to cause a motion of these atoms in opposite directions. This is probably the first indication of the idea of the purely directive character of the applied electromotive force taking advantage of dissociation to produce chemical separation.

The energy side of the problem now began to attract attention, and the development of what may be called the thermo-dynamics of electro-chemistry began. Among the most prominent workers in this field have been Joule, Helmholtz, Gibbs, Kelvin, Boscha and Favre.

In 1853 Hittorf made quantitative determination of the change of concentration near the electrodes when a current is passed through a solution. This work is of historical interest because it formed practically the starting point for what may be called the modern view of electrolysis. Hittorf's experiments extended over several years and served practically to establish the theory of the migration of the ions in the solution. Hittorf communicated the following laws:

The change in concentration due to current is determined by the motion which the ions have in the unchanged s lution.

The unlike ions must have different velocities to produce such change of concentration.

The numbers which express ionic velocities mean the relative distance through which the ions move between the salt molecules, or express their relative velocities in reference to the solution, the change in concentration being a function of the relative ionic velocities.

Hittorf's analyses enabled him to give numerical values to these relative velocities. The experiments of Nernst, Loeb and others have extended Hittorf's results, and have shown that in dilute solutions the relative velocities of the ions are independent of the difference of potential between the electrodes and are only slightly, if at all, influenced by temperature. Hittorf pointed out that a knowledge of the conductivity of electrolytes should give valuable information in reference to the nature of electrolytic action. A great deal of work has been done in this direction by Horsford, Wiedemann, Beetz, the Kohlrauschs and others. The most notable, perhaps, was the work of P. Kohlrausch, who devised a method of measurement, using alternating current, by which results of high accuracy were obtained. Kohlrausch's results give the sum of the ionic velocities, and thus, combined with the results of Hittorf on change of concentration, which gave the ratios, the absolute velocity can be obtained.

It appears from these results that the velocity of the ion in very dilute solutions depends only on its own nature and not upon the nature of the other ions with which it may be associated. For example, the velocity of the chlorine ion is the same when determined from solutions of KCl, NaCl or HCl. The important general law has also been found that the conductivities of neutral salts are additively made up of two values, one dependent on the positive, the other upon the negative ion. If, then, the velocities of the ions themselves be known, the conductivity of a salt may be calculated. The results of Kohlrausch received strong confirmation from some very ingenious experiments by Lodge and Wetham in which the migration of the ions was made to produce a change of color in the solution, and could thus be directly observed.

(To be continued.)

T. E. D. RITCHIE, 115 Broadway, New York City, has taken the Eastern agency for the Ft. Wayne Lamp Company.

Detroit, Mich.—Telephone Receiver Co. has been incorporated with a capital stock of $5,000.

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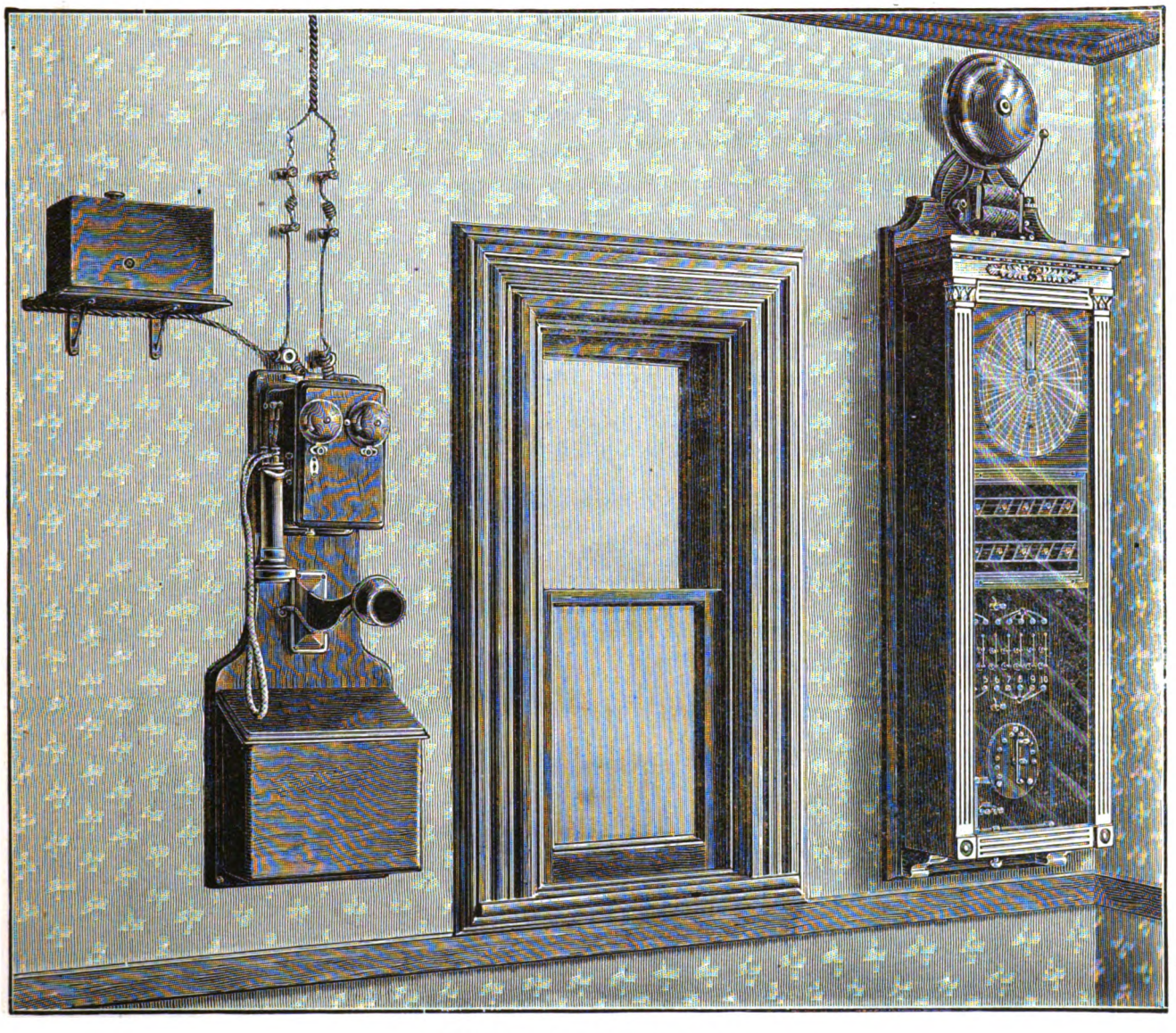
INTERIOR THERMOSTATIC ELECTRIC CABLES.

The introduction of thermostatic electric cables into residences and business houses for their protection against fire and burglars have rendered them safer than Morro Castle. The Montauk Multiphase cable, by whose use so much good is accomplished, consists of a copper conductor around which is placed a fusible core; then follow in consecutive layers a band of spirally wound tinned copper conductors, insulation covering them, copper conductors partially tinned, all copper conductors and what is called divisional insulation. Over the whole of this is drawn a woven covering that protects the cable from external injury.

At the second Electrical and Kindred Industries Exhibition recently ended, the Montauk Multiphase Cable Company of 100 Broadway showed in their booth to thousands of visitors the great advantages of this cable in case of fire or burglary. A match held to it melts the fusible core and causes contact between the conductors otherwise insulated from each other. This fusing effect immediately rings a large gong and so notifies tenants that a dangerous heat has arisen along the line of the cable. The cable could be connected with a central station by means of the multiphase controller which, operating in conjunction with the cable, will send word to the central station regarding the nature of the trouble, specifying exactly what the cause may be. This addition makes the cable indispensable to a complete telephone, fire-alarm or district-service system.

In the illustration we show the multiphase controller as mounted in any home, hotel or business house. The ever watchful eye of this cable makes it so reliable in the performance of its functions that its universal use as a protection against fire is a foregone conclusion.

The Montauk Multiphase Cable Company control a series of patents that make infringement impossible. For further particulars write to the address given above.



The Multiphase Controller in Use.

DEVELOPMENT OF THE ENCLOSED ARC LAMP.

While the credit for the technical development of the enclosed arc lamp is due to Prof. Marks, it is well understood that the commercial development is largely the result of the work of the Manhattan General Construction Co.

The first commercial successful enclosed arc was placed on the market by the Manhattan Co. in 1894, and since then the progress of such types of lamps has been so rapid that the enclosed arc has entirely superseded the old style of open-air arc lamps.

While the Manhattan Co. still furnish their old types of lamps, we give below a full description of their new improved types, which are designed to burn in multiple on direct-current circuits of from 90 to 250 volts, and in series on circuits of from 200 to 600 volts, and on alter-

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nating-current circuits of any frequency from 90 to 130 volts.

The principal defects which experience showed to exist in the old lamps were:

First—Length of 36 inches, which has been reduced to 29 inches.

Second—In the old lamp it was necessary in retrimming to remove entirely from the lamp the spider holding the pan, the inner bulb, the gas check plug, the carbon and sheath, all of which either had to be held in the hand or laid down while replacing carbons and cleaning the bulb. In trimming, both hands had to be used, and when the lamp was hot this method became a hardship.

Cut 3—The Lamp ready for Re-trimming, the Trimming Device being lowered.

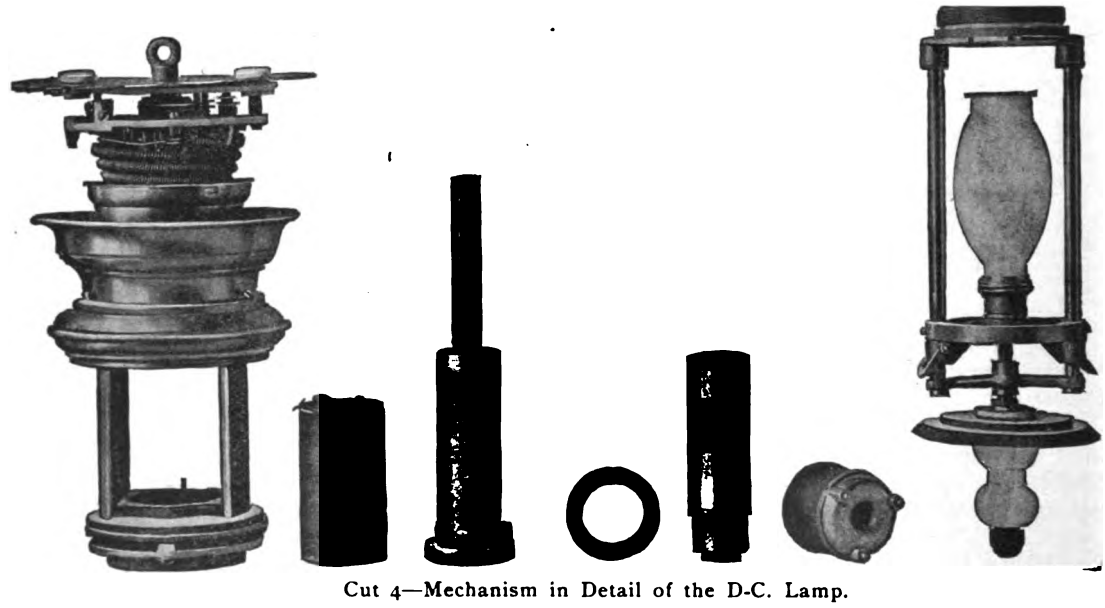
Cut 2—New Manhattan Lamp for both D.-C. and Alternating Current Circuits for Outside Service.

To provide, however, for cases where stations preferred to obtain entire uniformity of all parts required to be handled by trimmers, it has been arranged so that the new lamp may be furnished to take the old style of trim, or new style of trim may be furnished for old lamps now in service.

Trim is removed in shipment.

Third—In the old lamp the outer globe is stationary and a fixture on the body of the lamp. This saves handling, and many central stations claim that the saving thus made in breakage of outer globes nearly pays for renewal of inner bulbs, and this feature has been retained in the new lamp.

Fourth—In all other types of lamps the outer globe is lowered to give access to parts in trimming. In the new Manhattan lamp there has been introduced the novel feature of lowering the bulb down through the opening in the bottom of the outer globe on double telescoping rods. The inner bulb and carbons are thus through in full view below the lamp, and, after retrimming, the device, on being raised automatically, locks in position.



Cut 4—Mechanism in Detail of the D-C. Lamp.

To lower the trimming device it is only necessary to press the knob on the bottom of the lamp. Carbon sheath is removed as heretofore, but the current is fed to upper carbon directly through the sheath in place of a separate brush box as formerly. Contact between sheath and inner tube is made through metal balls contained in the sheath. Magnetism automatically attracts these balls against the sides of the inner tube and assures perfect contact.

Fifth—It is perhaps not sufficiently well understood

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that one of the secrets of the life of the carbon is largely dependent on the style of closure of the top of the inner bulb. The cap used in new Manhattan lamp is provided with a gas chamber, which materially lengthens the life. This cap is made under patents of L. B. Marks and Moses S. Okun, covering every form of cap having a gas chamber and lateral movement.

Sixth—In the old Manhattan lamp one of its great disadvantages was that to adjust the current it was necessary to take out the pan and bulb, take off globe and yoke, take the lamp down from its hanger, take off top plate, undo the wire connections, remove the rheostat, and take off shell from above. In the new Manhattan lamp the mechanism shell may be lowered while the lamp hangs in position by removing the trim and outer globe and giving the central cylinder a quarter turn, when the shell may be removed and current adjustment of the lamp changed.

The adjustment of the rheostat for voltage may be made by loosening set screws and lowering the split canopy at the top, as shown in Fig. –.

Seventh—While the great claim for the Manhattan lamp has always been its simplicity and the fact that it was made up entirely of heavy castings, it is very difficult to imagine how the number of parts could have been much reduced, but it will be found that all the mechanism below the armature has been dispensed with, and that the only moving part in the lamp is the armature, inside of which, however, is a ball clutch. The clutch of the old lamp consists of four rings passing through slots in the armature, and the whole lamp had to be taken down and apart to reach the clutch. For this has been substituted four balls which ride between the inclined surface of the inside of the armature and openings in the central brass tube. The armature and clutch may be removed from the lamp while it hangs in position, by undoing one nut.

Eighth—In the old lamp the part requiring most frequent renewal and which was the most general cause for repairs was the brush box, through which the current was fed to upper carbon. This has been entirely eliminated from the new lamp.

Ninth—One of the sources of danger to short arc lamps has been that the arc is so close to the mechanism there is a likelihood of burning out of magnet. This has been provided against by the use of a ventilated magnet, and a current of air is constantly passing between magnet and central tube.

Tenth—The steady burning of the old lamp depended absolutely upon perfection of the air chamber, which caused variation in burning of different lamps; also great nicety of manufacture, and it was impossible to make lamps altogether interchangeable. In the new lamp there is no such chamber, and a loose fit is maintained between all of the parts. In addition to the air chamber in which the armature works in the old lamp, a further chamber was provided around the clutch, making it necessary to take the shell off in a most inconvenient manner, and great care had to be used in replacing insulation at this point, which made the old lamp most difficult to assemble. This has also been remedied in the new lamp.

Eleventh—In the old lamp the proper assembling was its most important feature, and unless done with accuracy and the lamp lined up exactly it would not burn properly, and it was almost impossible for users of the lamp to take it apart and put together again without special tools. All of the parts were assembled with driving fits, whereas in the new lamp all of the parts are loose fits and may be removed with the fingers, and to entirely remove all of the parts of the lamp it is only necessary to remove two nuts.

The rapid extension in this country and abroad of the use of circuits of from 220 volts has caused a large demand for lamps to burn in multiple on such circuits. The new type Manhattan lamp has been designed for such service, and the mechanism of the lamp is exactly the same as the lamp above described, and the same lamp can be transferred from a 110 to a 220 volt circuit by the substitution of another coil and rheostat and a change of the nut holding the armature.

The same standard new type Manhattan lamp is also arranged to burn two or more in series on circuits of from 200 to 600 volts by a change of the magnet coil.

The development of the enclosed lamp for direct-current circuits has naturally caused much experimenting to be done with enclosed alternating lamps, and it seems as though the improvements in mechanisms brought about by enclosed lamps have enabled those experienced in lamp construction to produce lamps that would be acceptable both commercially and electrically.

Access to the mechanism may be had while the lamp hangs in position by removing the globe and trim and giving the mechanism shell a quarter turn.

The trimming device is removed in shipping, as in the D. C. lamp.

The Manhattan Co. state that they have been working on this lamp for nearly a year, and have put the same through continuous commercial tests, and do not hesitate to state that the lamp will maintain the high reputation of the company.

It is economical and reliable. It starts up quickly, and without chattering, will run without variation of current and quietly from 100 to 130 volts where such variation is found to exist, without readjustment.

The lamp will burn 100 hours with one 9½ inches × ½ inch upper, and one 6 inches × ½ inch lower carbon, and the unburned portion of the upper may be used as a lower for the next run. On circuits of 100 volts, six amperes, the lamp consumes 450 watts. The length of the lamp is 29 inches.

The lamp may be adjusted by a simple change of connections on the top plate for circuits of from 7,200 to 17,000 alternations, and has a range of adjustment for voltage of from 90 to 130 volts.

In designing these new types of Manhattan lamps there has been but one consideration in mind—Quality.

These Manhattan lamps are manufactured under Patents of Marks Enclosed Arc Light Co., Moses S. Okun, Max Harris and others.

The first company to recognize the validity of these patents and to protect themselves in taking out a license was the Manhattan Co., and since that time licenses have also been taken out by the General Incandescent Arc Light Co. and Electric Arc Light Co., and it hardly seems possible that three concerns such as these would, with their thorough knowledge of the situation, recognize the strength of basic enclosed arc patents unless the chances of their maintenance is considered to be more than a possibility.

Philadelphia, Pa. — Standard Traction Co. has been incorporated by Maynard L. Young, Edwin F. Morse, William S. Doran, J. Howard, Reber and William F. Sullivan. Capital stock, $1,000.

Portland, Me. — The Union Telegraph Co. has been incorporated with G. A. Beaton, treasurer, to acquire and operate telephone lines and handle apparatus. Capstock, $10,000,000.

St. Louis, Mo.—The Mississippi Valley Electrical & Manufacturing Co. has been incorporated by Edward Buden and others, with a capital stock of $100,000.

Athens, Tenn.—City Clerk may give information concerning light plant which will be established.

Harriman, Tenn.—A new incandescent light plant will be established.

Winchester, Tenn.—A local telephone exchange will be established at an early day.

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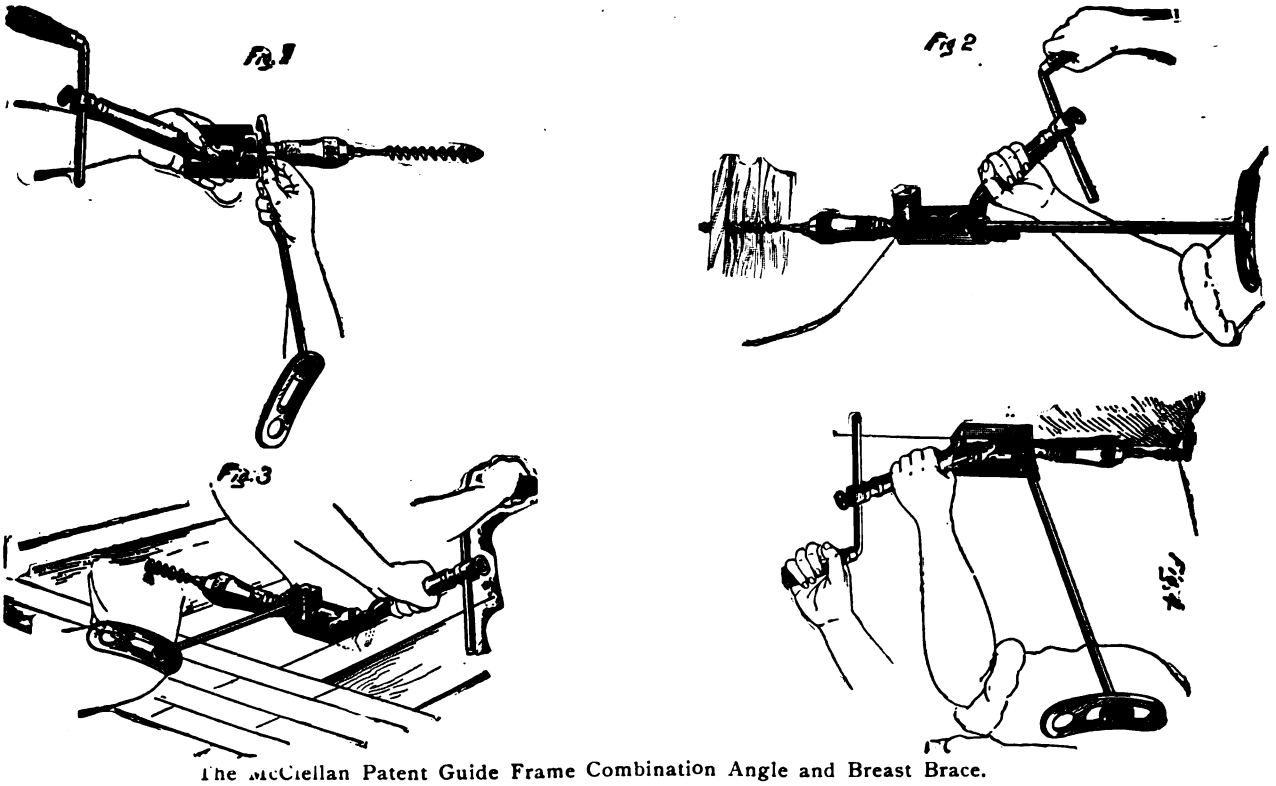
A COMBINATION ANGLE AND BREAST BRACE.

The McClellan patent guide frame combination angle and breast brace, illustrated in this article, is used to the greatest advantage in cases where it would be impossible to bore a hole with any other tool. This advantage



The McClellan Patent Guide Frame Combination Angle and Breast Brace.
Fig. 1 represents assembling the breast rest into one of the positions. Fig. 2 being used as an ordinary breast brace.
Fig. 3 in use boring between joist in floor. Fig. 4 overhead, in corner, or between upper celling joist.

makes it the superior of all other breast braces. Its use for corner boring makes it unique, and the facilities with which holes can be bored in a limited space with accuracy and speed leaves nothing to be desired in this piece of apparatus. The breast brace can be readily taken apart, the breast rest can be detached and the handle so adjusted as to have a radial sweep of from four to thirteen inches. This article finished with a hardwood handle, either nickleplated or japanned, is for sale by Patterson Brothers, 27 Park Row, New York.

CANADIAN LETTER.

ELECTRICAL NEWS.

Wallaceburg, Ont.—The Wallaceburg Electric Light Company contemplate putting in an incandescent plant, having agreed to do so within eight months.

Stanbridge, East Que.—Mr. S. Cornell will install an electric light plant next spring.

Thamesford, Ont.—Electric light is being agitated.

Quyon, Ont.—An agitation is on foot to have better fire protection.

Cambellton, N. B.—The ratepayers have voted in favor of electric light.

Annapolis, N. S.—The by-law authorizing the town to operate its own electric light plant and to borrow $12,000 for the purchase of a plant was defeated by the ratepayers.

ELECTRIC RAILWAYS.

Amherstburg, Ont.—A company in Detroit has made a proposition to build an electric railway between this place, Windsor and Harrow, and want a bonus of $15,000. Mr. Joseph De Curse, C. E., has made estimates for grading, bridges, culverts, etc. Several bridges will be required if the road is proceeded with.

St. Catherine's, Ont.—A company is said to have been formed and plans matured for building an electric railway between St. Catherine's and Port Dalhousie, ready for operating April next. H. D. Symmes, manager of the St. Catherine's and Thorold electric road, is at the head of the new company.

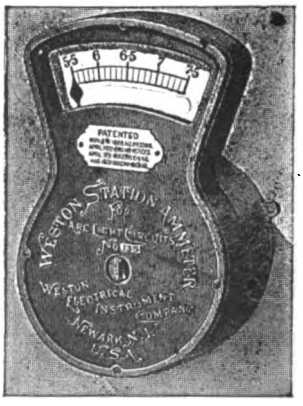
J. ALCIDE CHAUSSÉ.

Port Jervis, N. Y.—The Port Jervis Light & Power Co. will construct an electric plant to cost about $50,000.

Sault Ste. Marie, Mich.—The Edison-Sault Electric Co., president, H. Dunbar; manager, W. F. Kingan; will make improvements to its plant at cost of about $75,000.

Berlin Falls, N. H.—The Northern Electric Co., recently incorporated, will build an electric light plant.

Charlotte, N. Y.—George P. Goulding may give information concerning construction of electric-light plant at an estimated cost of $10,000.



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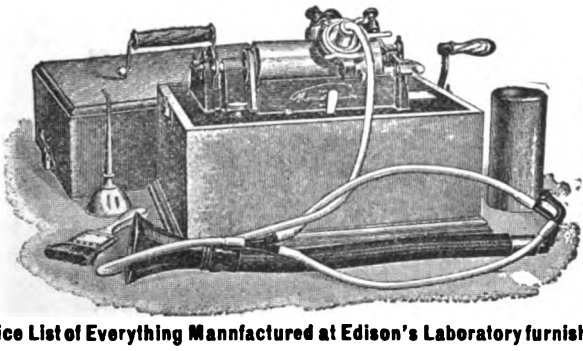

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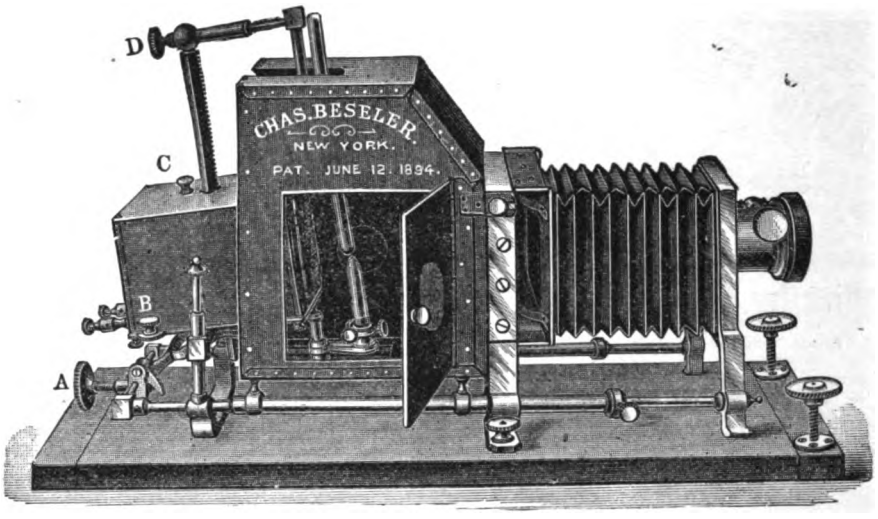

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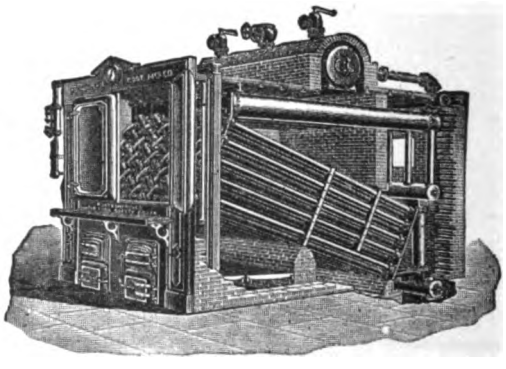

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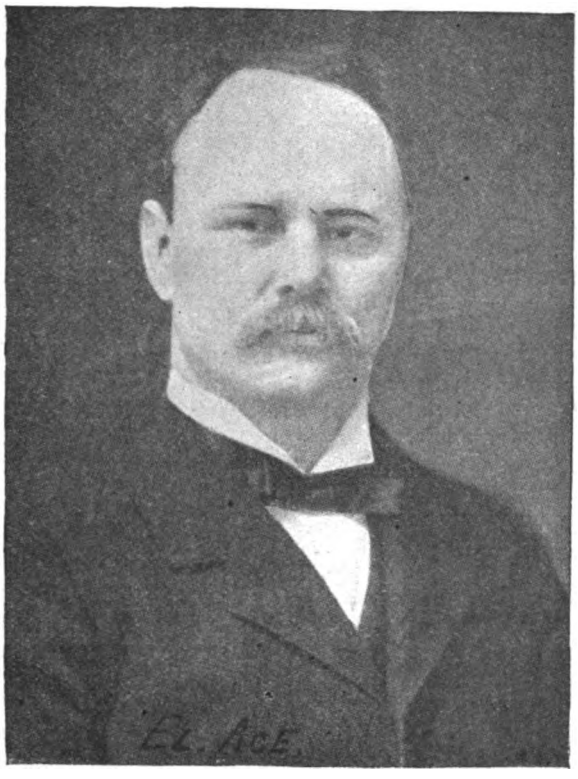
The Electrical Age.

VOL. XXI—No. 25 NEW YORK, JUNE 18, 1898 WHOLE No. 579



Mr. Alden M. Young, of Waterbury, Conn., President of the National Electric Light Association.

MR. ALDEN M. YOUNG, of Waterbury, Connecticut, was unanimously elected President of the National Electric Light Association at the last meeting, held in Chicago. He has been closely allied with the electric light, power and railway business for a number of years throughout New England. He is president of the New England Engineering Co., of Waterbury, Connecticut, whose interests are identified with a number of electric light and power plants throughout New England. Mr. Young was born at Hadley, N. Y., in 1853, being an old telegraph man, like a large majority of the successful men in the electric lighting business. He represented the old Atlantic & Pacific Telegraph Co. in a number of big cities in New York state. In 1878 he took up the telephone and organized a company in Waterbury, Conn., and it became a valuable property. Spreading out into the lighting and street railway lines, everything he undertook became successful. As president of the New England Engineering Co., he is engaged in the building of complete electric light, power and railway plants, steam and gas plants, and construction work of all kinds; secretary of the Waterbury Traction Company; president of the Central Railway & Electric Company, New Britain, Conn.; secretary of the Norwich Gas & Electric Company, of Norwich, Conn., and an officer in a dozen or more electric companies in the states of Connecticut, New York and New Jersey.

Probably the most important and interesting venture originated by Mr. Young is an undertaking now being developed in the Borough of Brooklyn, New York City. In May, 1897, he purchased the franchise of the Kings County Electric Light and Power Company of that city, and immediately started to financiering same, which he successfully accomplished, interesting some of the best-known men of New York and Brooklyn. The capital of this company is two and a half million dollars. The plant is nearly completed and will be one of the best equipped in the country, Mr. Young having given it his personal attention.

The interests with which he is personally identified represent investments running up into millions of dollars, and all paying good dividends. Mr. Young's knowledge of building successful lighting plants will become a big factor in the Association, and the members can congratulate themselves on their choice for presiding officer.

REPORT OF THE PROCEEDINGS OF THE TWENTY-FIRST CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION,

HELD AT THE AUDITORIUM HOTEL, CHICAGO, ILL., JUNE 7–9, 1898.

President Insull, of Chicago, called the meeting to order at 11 o'clock on Tuesday morning. There was the largest attendance ever present at an opening session of a meeting of the association, and the attendance and interest in the proceedings was sustained throughout the convention. There were four hundred delegates and visitors present.

Letters of regret at their inability to attend the meeting were read from First Vice-President A. M. Young, Waterbury, Conn.; Thomas A. Edison and Nikola Tesla, New York; Prof. Bovey, Montreal, and Elihu Thomson, Lynn, Mass.

Invitations to accept hospitalities were read from the

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Metropolitan West Side Elevated Railroad, South Side Elevated Railroad, Northern Steamship Co. and the American Telephone and Telegraph Co.

The first paper was on the "Cost of the Generation and Distribution of a Unit of Electricity," by Calvin W. Rice, of Brooklyn, N. Y.

In the discussion on this paper a question arose as to the comparison of the losses between gas and electricity. Mr. Barker, of Boston, said that the occasion for loss in the gas distribution was largely leakage in the pipes; the matter of condensation loss was reduced to a low percentage, with the improved appliances in the production of gas. Mr. Coggshall, of Fitchburg, stated that the loss of output by alternating current from the 1st of January to the 1st of April was 53 per cent.; the loss existed largely in the transformers. Mr. Wagner, of St. Louis, thought the meters might not have registered the full amount of current used. Mr. Coggshall agreed with him; they had put in meters which required twenty lamps to make them register at all. President Insull then exhibited a chart illustrating the operating expenses of the Edison Chicago station, in which he showed that the most important point is the interest cost; you might have all your operating expenses, outside of interest, presented to you, and then you could lose money; it would be possible to do such a thing, if your selling price is not on the right basis. He said that it was generally supposed that the best business is the power business; that you could afford to sell power at one-half the price, if your current was not going to be used for light; it was found that the power curve and the light curve cross each other for sixty days during the winter, and the claim that was made for the power business proved a great fallacy.

Mr. Dow, of Detroit, gave an interesting account of the operation of the Wright demand meter. The Wright demand meter is so far the most satisfactory method of recording the maximum that a customer takes at any time; the principle is the same as that which governs the registering thermometer, the style of thermometer which not only shows the present temperature, but which, at the highest point it reaches, leaves a little globule of the colored alcohol, so that any one on inspeting the thermometer can tell, not merely the present temperature as he can by looking at any other thermometer, but he can tell to what point the alcoholic column has risen since the thermometer was last set. The setting is accomplished by shaking down the retained globule, and the process of resetting in the Wright meter is the same. The metre has a fluid which is expanded by the electric current, and it leaves an indication showing that some time since you last set the meter the cnstomer has used current to a certain extent, not that he has used so many watt hours, but that at one time for several minutes he called for so many amperes and used it simultaneously. That indicates the largest amount of machinery you have to install to take care of the customer.

Mr. Ferguson, of Chicago, said that their business had largely improved by the use of the meter, and they cannot get instruments fast enough; he thought that any company could well afford to buy the meters, even if they had to borrow the money. Mr. Weeks, of Kansas City, stated that in the cost of our product the relative value of the interest factor has been forcibly and clearly shown, and the necessity for revision of rates or discounts has been ably demonstrated. He thought it was somewhat inequitable to make a lower rate for transient summer service, such as that of the customer who operates a fan but a few weeks or months at most in the year, while his rate on account of the interest factor should be higher rather than lower than that for most other classes of service. Mr. Ferguson being asked as to the effect of the Wright meter system on municipal service, said that it would not get as low as it is being sold now. It could be readily seen that if the rate is twenty cents the first hour, and ten cents for everything after that, the maximum discount will not reach 50 per cent.; it is something higher than that now. It is the same as if you make the rate ten cents per kilowatt hour. You will have to make the second rate low enough so as to figure out the same kilowatt hour as you are now charging for the arc-light service; that must be arranged for in each individual city.

At the Tuesday afternoon session, the paper by Mr. Alexander Dow, of Detroit, on "Public Lighting, with Relation to Public Ownership and Control," was read, followed by papers on the same topic by Samuel Scovil, of Cleveland, and H. M. Atkinson, of Atlanta. At the conclusion of the reading of these papers the convention adjourned to executive session.

The first business of the Wednesday morning's session was the reading of two papers—"General Distribution from Central Stations by Alternating Currents," by Herbert A. Wagner, of St. Louis, and "General Distribution from Central Stations by Direct Currents," by Louis A. Ferguson, of Chicago.

The discussion on these papers was opened by Prof. Fujioka, of Japan, who gave an interesting account of the electric lighting installation in the city of Tokyo, Japan, where they used the Edison three-wire system. Their cost of production was high, as coal there costs six dollars a ton.

In answer to a question, Mr. Wagner said that by making the transformer practically an integral part of the feeder, they eliminate all the effects of transformer dropping, just as they do the feeder drop by regulating the pressure wires from the feeder terminal, which become the secondary terminals of the transformer, so that they can sacrifice the regulation of the transformer to secure a very low iron loss; a poorly regulated transformer is very much better for use in a system where transformers are connected in multiple, provided the pressure for each transformer can be regulated independently; the transformers of very close regulation, one per cent. or under, are connected in multiple, with two or three hundred feet of mains in between, and unless the resistance of the mains is extremely low, the transformer will not handle the load, unless it is uniformly distributed along the main. Prof. Goldsborough, of Purdue, Ind., said that if a system of sub-stations could be devised and a number of transformers placed together, and a set of feeders could run from the central station to the sub-station and some of the transformers could be cut out, that there would be a gain there, and a certain number of the feeders would be used in common with a certain number of transformers. In that arrangement you would have less core losses, and consequently you would have improved efficiency in the lower loads. Mr. Rice, of Brooklyn, mentioned that he had visited the stations at Salt Lake City and Sacramento, and spent several days with the designing engineers of both cities, and they both claimed superior efficacy and elasticity for the Edison three-wire system. They have the three-phase four-wire distribution. He thought that Mr. Wagner's example of the alternating plant was unfortunate, in that it does not represent an alternating plant of the latest design. It was now past discussion, he said, that alternators may be thrown in parallel, the same as the continuous current generators. The use of motors is a feature which is coming into prominence, but the alternating motors have not been developed and applied the same as continuous current motors, because they had not lived long enough; in time he expected to see alternating current motors distributed as widely and as universally as continuous current motors. The same idea applies to the arc lamp; we have had arc lamps for a great many years on the continuous current system, but only recently have they been developed and made acceptable on the alternating current system.

(To be continued.)

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HEAVY ELECTRIC RAILROADING PROPOSED IN FRANCE.

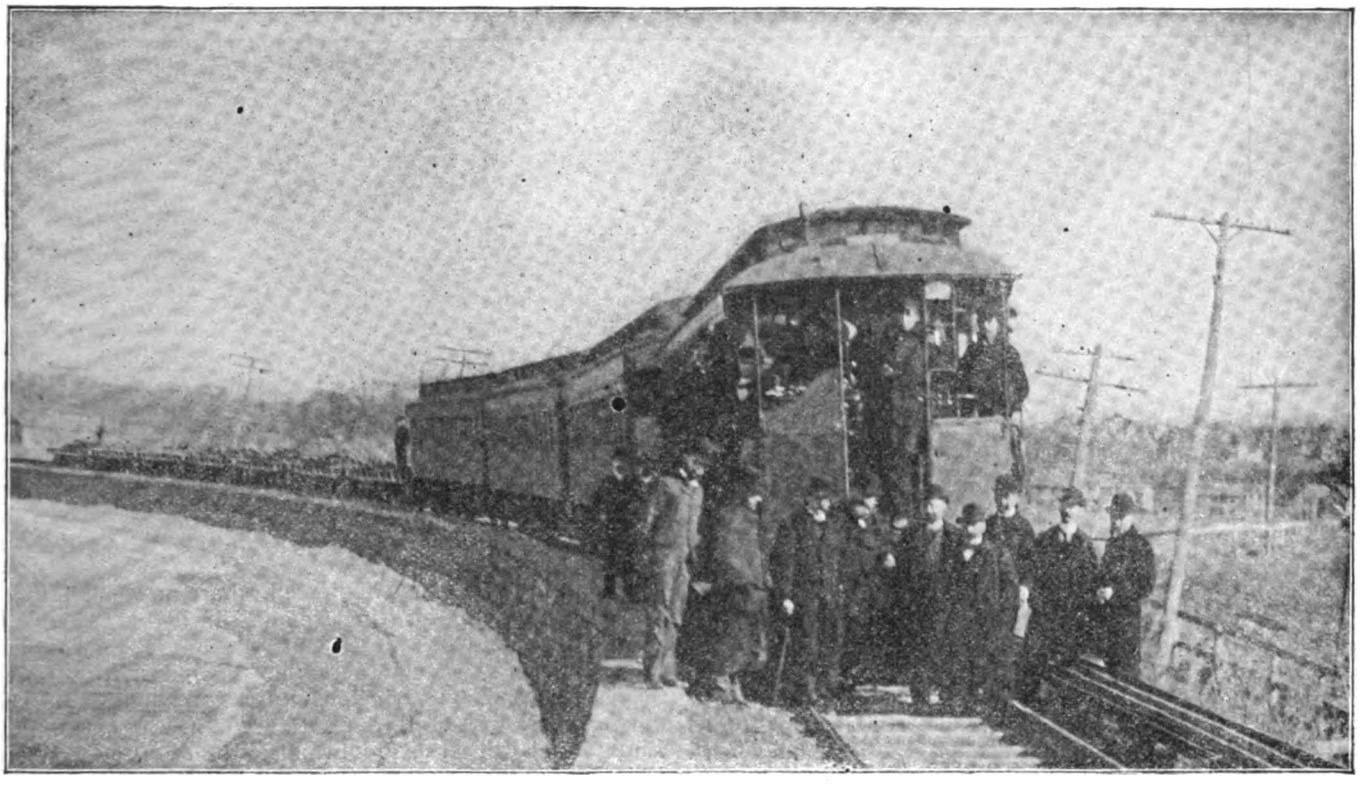
An enterprise involving the expenditure of not less than forty million francs, or eight million dollars, and the creation of a road, about 2½ miles long, partly underground, to be operated exclusively by electricity, is about to be undertaken in the city of Paris by the Orleans Railroad. The main terminal of this railroad, which operates about 4,300 miles of track in the West and Southwest of France, is at the Place Valhubert, near the Pont d'Austerlitz and the Jardin des Plantes, in the extreme east of Paris.

The travelling population of Paris does not live in the eastern part of the city but in the western, in which direction the city is steadily growing, and access to the present Orleans station in most cases involves carriage transportation. The Orleans Company has, therefore, decided to prolong its line into the very heart of Paris, and for this purpose has secured a right of way underground to a point on the left bank of the Seine opposite the Garden of the Tuilleries, where it will erect a terminal station. Visitors to Paris, since the year 1872, have had the ruins of the Cour des Comptes pointed out to them as an example of the ferocity of the Commune ; it is on this spot that the new Quai d' Orsay station of the Orleans Railroad is to be erected.

The new road will have two tracks and will drop from the Valhubert station on a grade of 1.1 per cent. towards the Seine. Here the river banks are in two stories—an upper quay or roadway, and a lower quay used as a dock or wharf for canal boats. A belt nine meters wide has been secured on this lower quay, and the line will follow this in the open for 650 meters. It will be an underground road beneath the upper quay for the remainder of the distance until it reaches the terminus under the Cour des Comptes. Openings in the wall side of the quay facing the river will afford light and ventilation. The rail level is about that of the normal height of the water; any seepage water in times of flood will be gathered in a sump and drained out.

The road follows the line of the Quai's St. Bernard de la Tournelle, de Montebello, St. Michel, des Grands Augustins, de Conti, Malaquais and Voltaire to the Quai d'Orsay, passing the bridges Austerlitz, Sully, de la Tournelle de l'Archeveche, au Double, St. Michel, Neuf, des Arts, du Carrousel, Royal and Solferino. From the Pont Sully to the Petit Pont the underground construction will be a masonry arch of nine meters span for a length of about 900 metres. From this point, for another 500 metres, the upper roadway will be caried by a metallic arch, and for the balance of the distance the masonry arch construction will be resumed with a span of about eight metres.

About half way between the Place Valhubert and the Quai d'Orsay, between the Petit Pont and the Pont St. Michel, a station will be built, known as the station du Pont St. Michel. The Quai d'Orsay station, the terminal station, will lie between the buildings of the Caisse des Depots at Consignations and the Palais de la Legion d' Honneur and between the Pont Royal and the Pont de Solferino. It has been designed by M. Sabouret, Chief Engineer of the Central Service. The Orsay station will have fifteen tracks, any one of which can be used for arriving or departing trains. According to the present plans, the three tracks nearest the river will be used for side tracks, the next four tracks for long distance departing trains, the next two for arriving and departing suburban trains, the next two for arriving long distance trains, the next two for arriving and departing suburban trains, and the last two stations for station service.



Test Train at General Electric Co.'s Works, Schenectady, N. Y.

The platforms of the Pont St. Michel station will be 230 metres long. Those of the Quai d'Orsay station 185 to 240 metres long and six to seven metres wide. They are, of course, raised to the height of the footboard of the cars, so that these may be entered directly from the platform. The arriving traffic will come in from the Rue de Bellechasse and the Rue de Lille, and the departing traffic will be concentrated on the Quai d' Orsay. A number of elevators will be installed to facilitate movement of passengers and baggage.

The rail level is 25 feet below the street level. The company has not been obliged to purchase the title to the surface, the structure overhead being carried by a

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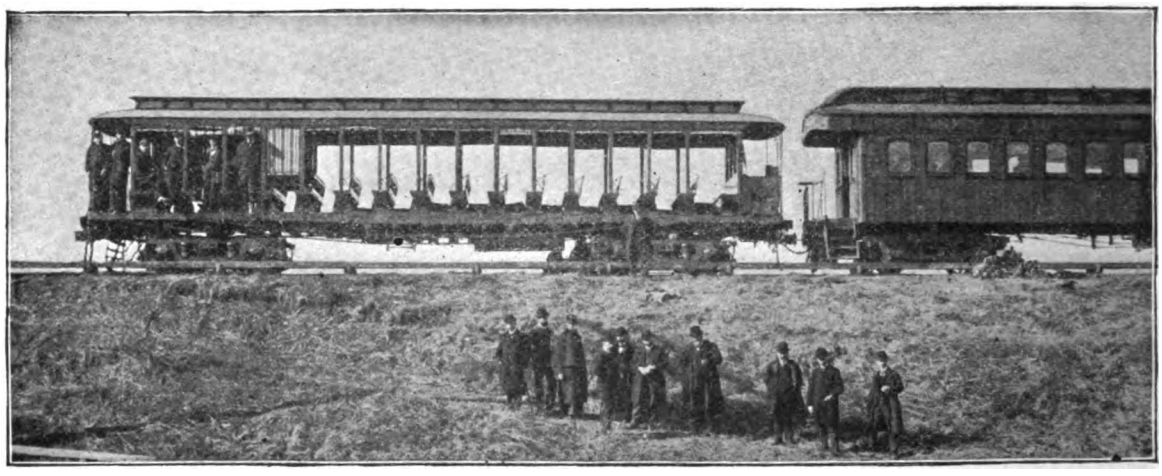
metal roof construction guaranteed by the company. The building above the station will probably be occupied by a large hotel and will, of course, be in harmony with the buildings in its vicinity. The design of M. Laloux have been selected and approved by the Minister of Public Works.

A short distance west of this station is the terminal station of the Ouest Railroad at the Invalides, and still further west is the small station of the Champ de Mars, the former a part of the main line of the Ouest Railroad, the latter an off-shoot from the Ceinture or Belt Line which encircles Paris. These stations will probably eventually be joined to the Quai d'Orsay station of the Orleans road, thus uniting the Ouest, Ceinture and Orleans systems.

In driving the underground tunnel, the Orleans Railroad will operate without interference whatsoever with the street traffic. The earth overhead will be supported by a metal shield pushed forward by hydraulic presses and



Group of French Engineers and the Test Train.

followed closely by the masonry. The method is similar to that employed in building the great sewer recently laid down in Paris.

The operation of this underground road, as at present contemplated, is to be carried on by means of electric locomotives driven by continuous current at a pressure of between 500 and 700 volts, using the third-rail system of contact. In asking for estimates, however, the company has requested bidders to submit plans also for the use of systems of generation and distribution other than that just mentioned. The locomotives are to be eight in number, all alike, and able to haul a train of 250 French tons in seven minutes between the stations of the Quai d'Orsay and the Pont d'Austerlitz without stopping at the intermediate station of the Pont St. Michel. This means a speed of 45 k. m. an hour. The locomotives should not only be able to haul a train of the weight mentioned on a grade of 11 m. m. and on curves of 200 metres radius, but should also be able to haul trains as heavy as 300 tons at a slower speed. The locomotives must be built to move in either directions at the same speed, and be of a length to allow them to be turned on turn-tables six m. 20 c. m. in diameter. They are to be equipped with motor-driven air pump for air brakes.

The electric generating station will be placed at the western end of the Valhubert station departing platform, taking the place of certain waiting rooms. The equipment is to be of sufficient capacity to allow of the simultaneous movement of four 200-ton trains, exclusive of the locomotive, upon the line—one starting from Austerlitz station, one from the Quai d'Orsay station, the third climbing the grade of 11 m. m. and the fourth running between the Pont St. Michel and the present main station. Furthermore, the generating plant must include sufficient lighting capacity for three stations already mentioned and the tunnel as well as for the station and shops at Ivry. The current is to be taken by the locomotives from an insulated third rail at the side of the track in the stations and between the tracks over the rest of the line, due provision being made for all switches and crossovers.

In order that a better knowledge of the operation of electricity in heavy traction service might be gained than was possible in Europe, the Orleans Company recently sent over to America a corps of engineers to investigate the different electric railway installations of this type in this country. The party was headed by M. E. Solacroup, assistant chief engineer of material and traction, and M. Sabouret, already mentioned, the other members being Messrs. Hiberty, Fremenville and Walton. Their inquiries were conducted very quietly, but during their short stay they were able to visit almost every installation of special interest to them in the United States. The investigation was begun at Hoboken, where an electric locomotive is hauling all the freight service between the transatlantic docks there and the West Shore and Erie Railroads. From there they visited Baltimore, to inspect the great electric locomotives which operate the entire traffic of the B. & O. Railroad through the Belt Line tunnel in that city. From Baltimore they went to Chicago, for the purpose of observing the operation of the electric elevated railroads, and, returning East, passed through Cleveland, Niagara Falls and Buffalo, where they had an opportunity of studying the employment of the electric car in high-speed interurban service.

From Buffalo they travelled to Boston where they were met by C. P. Clark, President of the New York, New Haven and Hartford R. R. and Colonel N. H. Heft, Chief Electrician of the same road. They travelled on the Nantasket Branch of the New Haven system between East Weymouth and Hull, and inspected the power-house. Returning they visited the third-rail electric system between Berlin and Hartford, Conn., opened for traffic last summer, and rode on the 30-ton electric locomotive operating between factories at New Haven and the Cedar Hill Junction.

A special test was arranged for their benefit at Schenectady on the experimental two-mile track of the General Electric Company, the conditions of the track and load being, as far as possible, similar to those which will obtain on the line in Paris. A length of track was marked off 1.11 of a mile long, by two white flags, corresponding to the distance between the Quai d'Orsay and the Pont St. Michel stations, the most difficult portion of the proposed Orleans extension. According to the time schedule arranged for the operation of the road, this distance should be covered in three minutes and fifty seconds. A

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train was made up of a motor car of the Nantasket Beach pattern, equipped with four G. E. 55–175 H. P. motors as locomotives, several New York Central coaches and seven flat cars loaded with pig iron, making a total train load of 320 tons including the motor car, which weighed 45 tons. The run between the flags, including starting and stopping, was made easily in three minutes and twenty-five seconds, giving a margin of not less than twenty-five seconds to the good. The diagram on this page shows the acceleration curves of this run.

The question of rendering the third rail innocuous after the passage of the train having been brought up, the General Electric Company arranged an exhibition of its method of effecting this result. A section of the third rail was measured off and divided into sections in lengths varying from 30 ft. to 500 ft. Connections were made between these and a system of automatic switches, and the conditions of the General Electric system of surface contact, almost exactly reproduced. By this system, the arrangement of circuits is such that the sections into which the rail is divided may be of any length from that of a few feet to any number of miles, that is, any section of the conductor rail will be alive only when the train itself is running over that section. The instant the train passes to the succeeding section, that which it has just left becomes dead and absolutely innocuous. The use of this system also renders it possible to "section" the conducting rail at stations, leaving it continuously alive at all intermediate points. The switch cutting the dead section into circuit is closed as the contact shoe of the train comes into contact with the conductor, energizing it, and is automatically opened as the train passes to the next dead section.

The motor car was run over that part of the track beside which the third rail was sectioned, and as a visual means of indicating that the third rail was alive a number of incandescent lamps on top of the boxes containing the switches were connected to the conductor. As the car reached the sections and rendered them alive, the lamps lighted up, being extingushed as the contact shoes passed over the dividing lines between the different sections.

These tests formed the subject of the concluding investigations of the French engineers in this country. A few days before their departure a dinner was tendered to them at Delmonico's, at which many prominent railroad engineers and electricians were present to meet them. They admitted having received many new ideas during their stay; and return to France convinced of the use and possibilities of electricity as a motive power, especially in the field of heavy traction.

OPENING ADDRESS BY SAMUEL INSULL, PRESIDENT. *

MEMBERS OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

Ladies and Gentlemen:

In calling to order the annual convention of your Association my dual capacity presents somewhat of an embarrassment to me. I am in doubt whether as president to enlarge upon the great growth of this Association since its formation in this city on February 25, 1885, or whether as a resident here to dwell at length upon the marvelous growth of the city in which we meet. Chicago and the industry with which we are identified have a somewhat close connection. The growth of the former, if measured from the point of view of the rapidity with which history is made, is, so to speak, the product of yesterday. The electrical industry, or rather that portion of it with which we are associated, is but little more than the product of to-day. If the growth of this city and that of our own industry is as great during the next thirteen years as the progress that they have achieved since the date of your first meeting here, I am sure that both the citizens of Chicago and the members of your Association will have every reason to congratulate themselves. Speaking for those of my friends connected with the electrical industry in Chicago, and also for myself, I can assure you that it affords us very great pleasure to welcome you at this convention, and the fact of your meeting in this, my home city, enhances not a little my high appreciation of the privilege of presiding on this occasion.

The officers of your Association have had in mind in preparing a programme for this convention the importance of bringing before you subjects of interest in connection with central station management, and the papers to be read at our various sessions and the topics mentioned for discussion cover such a wide range that it would seem undesirable for me to occupy much of your attention by way of introduction. The various gentlemen who have so kindly consented to read papers will deal with such important questions as the cost of generating and distributing the product which we manufacture, transformer economy, and the rival claims of alternating currents and direct currents as means of distribution. The many problems which you have to solve in connection with the question of public lighting and the cost of producing electrical energy by water power will also be discussed.

Standard vs. Special Machinery.

A matter which has called forth during the last year considerable discussion is the question of the use of standard apparatus and the tendency towards the specification of special machinery on the part of electrical engineers. This course is not by any means confined to large work, but is followed by some engineers whether they are designing a small isolated plant or are projecting a large modern central station. It would seem to me to be of paramount importance to the manufacturer and user that both should co-operate in eliminating as far as possible from the business the necessity of building and using special types of machinery. This can only be done by the adoption of standard specifications for various standard types of apparatus. A committee of the American Institute of Electrical Engineers has already taken this subject under consideration, and I believe that we will be serving alike the interests of the manufacturers and users of electrical apparatus if we will take some action with a view to co-operating with the institute and other bodies in this matter. In drawing attention to this subject, I speak with an appreciation of the position of both manufacturer and user, having had more or less connection with the manufacture of electric apparatus and the manufacture of electric current. Constant duplication of parts resulting in constant duplication of a given piece of machinery means, as any manufacturer will tell you, constant reduction in cost. Variation from a given type means increased cost and even the wiping out of an apparent profit.

In the last year or so there has been a great deal of discussion in England prompted by the success of American manufacturers in obtaining large contracts for electric traction work in Great Britain, and the inquiry has often been made, how is it possible for American electrical manufacturers, with high wages against them, to compete with English builders, whose scale of pay to their workmen is on a very much lower basis. If you will examine into the amount of electric traction machinery manufactured in this conntry under a system of constant duplication and the use of special tools, and then visit the electrical establishments on the other side of the water and note the tendency there towards specializing each particular job, you will soon recognize that the reason for low cost and consequently low selling price on

(Continued on page 344.)

* Delivered before the National Electric Light Association at its twenty-first Convention, held at Chicago, Illinois, June 7th, 8th and 9th, 1898.

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N. E. L. A. CONVENTION EXHIBITS AND ATTENDANTS.

The National Carbon Company was represented by Richard O'Connor, with a neat line of samples.

Chas. A. Schieren & Company were represented by A. W. Watriss, with all styles of belts in his pockets.

Wallace Electric Company had a nice exhibit, and the guests and friends were well attended to by Messrs. Hine and Barr.

Messrs. Varney & McOuat, electrical novelty men of Indianapolis, were represented by G. E. Varney.

L. H. Rogers told the people how much better Fort Wayne lamps would burn than any other competitor.

The Culter-Hammer Manufacturing Company showed their most excellent circuit breakers and motor starters, and had the same explained by Mr. Culter, of the company.

Mr. S. M. Hamill, of the Brush Electric Company, disappointed his many friends by his absence.

The Zamell Arc Light Meter Company, of 266 Blue Island avenue, Chicago, Ill., was represented by A. G. Zamell.

President Marsh and Western Manager Hill made their presence known by presenting the great merits of the Bryan-Marsh lamp.

The National Conduit & Cable Company, of New York, was well represented by G. J. Jackson, the original paper cable man.

An array of talent was seen at the convention in the representatives of the Triumph Electric Company, of Cincinnati. They triumphed in every way.

The Washington Carbon Company, the well-known makers of pencil and battery carbons, were represented by J. S. Crider, the secretary of the company.

Mica was never shown to better advantage than at this convention. Mr. John Child, the western representative of A. O. Shoonmaker, of New York, exhibited a beautiful specimen, 32 inches by 14½ inches, which attracted considerable attention.

Messrs. Partridge & Speer, of the Partridge Carbon Company, were missed at this convention. Many inquiries were made for them.

The Fort Wayne Electric Corporation was never better represented than at this convention, by Mr. F. A. Wunder.

The delegates and friends at this convention were well looked after by Mr. Chas. Holmes, manager of the supply department of the Chicago Edison Company.

All the gentlemen attending the convention, members and guests alike, expressed great pleasure for their kind treatment by the management of the Auditorium Hotel.

The American Carbon Company, Noblesville, Ind., was represented by Edmund Dickey.

The Royal Electric Company, Peoria, Ill., were represented by Mr. G. Luthy and Electrical Engineer Scheefer.

Hart switches were well displayed by Geo. S. Searing.

Chas D. Shain was on deck as usual, so that we did not misprint his face even if we misprinted his title. He was received by the usual delegation of friends.

Messrs. F. H. Smith, manager, of Pittsburg, and C. A. Ross, of Chicago, attended to the beautiful exhibit of incandescent lamps of the Sawyer-Man Electric Company.

The Northern Electric Manufacturing Company, of Madison, Wis., were there in the person of Edward Kohler.

The Standard Underground Cable Company, of Pittsburgh, Pa., is well looked after by Mr. J. R. Wiley, manager of the western sales department. He was assisted by Mrs. Paterson and Miss Wiley, his two favorite sisters.

The American Electric Heating Corporation, of Cambridgeport, Mass., was looked after by General Manager J. I. Ayer.

The Westinghouse Electric & Manufacturing Company's interests were well looked after by Mr. Arthur Warren, the new manager of the advertising department. We wish him success in his new position.

The Munson Belting Company was never better looked after than by the favorite among the boys, Col. Shay. Electric light men like him for his suave manner.

Henry C. Adams, Jr., the secretary of the Phillipps Insulated Wire Company, was on deck.

President John C. Boss, of the Lakon Company, of Elkhart, Ind., manufacturers of transformers, was kept busy answering the inquiries of possible buyers.

J. C. Shainwaldt, of P. & B. paint popularity, was on hand and well received.

Mr. Frank DeRonde, manager of the Standard Paint Company, makers of the famous P. & B. brand, is greatly missed at this convention. He is now captaining his Jersey Company at Tampa, Fla., ready for a Cuban invasion.

President H. B. Cutter, of the Cutter Electric & Manufacturing Company, of Philadelphia, was on hand and kept busy throughout the meeting.

Capt. Willard L. Candee and Geo. T. Manson, the two famous Okonite wire men, had their usual new souvenir in the shape of a beautiful miniature girl. Of course, everybody wanted one. Who wouldn't? Messrs. Candee and Manson were never in greater demand.

The Walker Company were represented by J. H. Gates, G. B. Foster and C. H. Philbrook. These three popular gentlemen found it necessary to keep open house, as they had a constant stream of guests during the convention.

The Mica Insulator Company, of New York, was represented by Chas. E. Coleman, of Chicago office.

The Northwestern Electrical Association was honored throughout the convention by Thos. R. Mercine. He kept the N. E. L. A. people thoroughly aroused to the fact that he was looking out for the interests of his association and their trip to Duluth.

H. H. Brooks, of the American Circular Loom Company, of Boston, was on hand as usual, and had no time for anything except business. We would like very much to receive one of those smoking outfits he presented to his many friends as a souvenir of the convention.

Col. S. G. Booker, of the Phœnix Carbon Company, St. Louis, was there during the convention.

Mr. N. E. Baird, of the Eddy Electric Manufacturing Company, was largely in evidence at this convention.

Manager Gilmer, of the Warren Electrical Specialty Company, Warren, O., was well pleased with the convention.

The Crouse-Tremaine Carbon Company and the Fostoria Incandescent Lamp Company were well represented by J. B. Crouse, the president.

The Sterling Arc Lamp Company, of New York, was well represented by R. J. Randolph, the manager. Mr. Randolph exhibited a fine line of enclosed arc lamps. He was right at home in Chicago.

The Armorite Interior Conduit Company was represented by the king of good fellows, Mr. James F. Cummings. Mr. Cummings also represented the Cummings Conduit Company, of Detroit, makers of a new tube, for which he makes great claims.

Edward H. Johnson, one of the most popular electrical men in this country and vice-president and general manager of the Sprague Electric Company, of New York, was a welcome member and exhibitor at this convention. He was assisted by Mr. Chas. A. Benton, of New York, and E. B. Kittle, western agent. Mr. Johnson and his assistants took all the members of the convention and their friends on a trip over the Alley "L" road to show them the new Sprague multiple-unit system. Mr. Johnson never enjoyed himself more than at this convention and was highly elated over his visit.

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The Electrical Age.

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ELECTRIC TRACTION ON TRUNK LINES.

At a lecture delivered some time ago before the American Institute of Electrical Engineers, the possibilities of electric traction at high speed were discussed by several eminent electricians. The conclusions reached were valuable, inasmuch as the immediate application of electric power to trunk lines was considered practical at so great a speed as one hundred miles an hour. Messrs. Crosby and Bell, the builders of an experimental line on which they had reached the velocity of one hundred and twenty miles an hour, mentioned, as the results of their own experience, that the road-bed, shape of locomotive, diameter of driving-wheel and several less important factors had an immense influence over the rate of speed attained and power consumed.

To quote from the paper treating of high-speed railroading, we find the following statement of great importance, "for the mechanical construction of the locomotive * * * . One had a twelve-foot rigid wheel base and no pilot wheels; the other had a seven-foot wheel base and a pony axle in front, free to move laterally over a certain distance, dragging the drivers in the same direction.

"This is the general principle of pilot wheels so largely used on high-speed engines. The second arrangement is preferred, for in it nearly all the weight goes on the drivers." In a volume written by Crosby and Bell, entitled "The Electric Railway," the fullest details of their work are given, which to even the casual reader will be of the greatest interest as marking a departure from the beaten path and an effort to increase the speed of electric railroading in a manner extremely practical. Mr. Crosby's opinion in relation to high-speed railroading is to the effect that the chances of derailing a train increase with the speed, but if the centre of gravity of the cars is very low it would be very difficult to cause an accident where the track is perfectly straight.

Another statement by Mr. Crosby is a very important one, as it regards track construction in a rather new light. The weight of the train and the state of perfection of the road will have everything to do with the speed which may be obtained under the circumstances. With a road built with rails of heavy steel, rigid enough to support the weight passing over them without bending, etc., a speed of one hundred and twenty miles an hour would be well within the limits of safety. Mr. Carl Zipernowski has offered plans for the construction of a road, the cars on which would move at a speed of one hundred and twenty-five miles an hour, between Buda-Pesth and Vienna. This road is to be devoted entirely to passenger service and would be built according to the latest scientific principles.

One of the difficulties, however, in high-speed railroad work would be the pressure used. About six thousand volts is not thought too great for the purpose; but this and other details would naturally adjust themselves when a road of this kind is under immediate contemplation. The great trunk lines of the United States are at present the fastest and most comfortable of any in the world, but they are objectionable because the speed is limited to an average of fifty miles an hour, and the coal dust thrown out by the locomotive is a great discomfort to travellers. The proposition to equip these lines with electric power has already come from two great corporations, not, however, with the intention on their part of operating at a higher rate of speed than at present. That is the objection.

Although the efforts of Mr. Crosby and others have been recognized as tending towards a solution of the important problem of high-speed train service on trunk lines, sufficient confidence in their work has not been established to make the present steam railroad corporations feel encouraged enough to make an investment of any amount. Consequently, it will be absolutely necessary for the promoters of high-speed railroad work to offer, as absolute proof of the success of any such undertaking, a comparatively short stretch of road upon which all sorts of tests may be made of a scientific, technical and general nature.

Certain tangible rumors have been afloat in the past to the effect that a line stretching from St. Louis to Chicago would be built at a speed running at one hundred and fifty miles an hour. While no value is placed upon these rumors by practical men, they at least show that the matter was under some consideration by capitalists, which might in the future develop into a serious undertaking. Although propositions of this kind may be built upon the flimsiest foundations, we thoroughly believe in the immediate possibility of establishing electric trunk lines upon which trains would fly back and forth at twice the speed of our proudest example of steam railroading, the "Empire State Express." The great corporations merely seem to be holding back at present before increasing their investment, or in any way transforming their road, simply because they require for their own individual satisfaction an electric road upon whose operation and construction they will be enabled to calculate the expenses and income incurred by any further development of that system.

The time for that transformation is at hand, and the attention of the civilized world is focused upon the builders and promulgators of electric railway enterprises.

Serial articles will be continued next week.

Spanish Mills.—The Massey Station Telephone Company propose to build a telephone line from Spanish Station to Spanish Mills. H. L. Glover and R. H. Harvey are interested.

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this side of the ocean is brought about by the fact that in America this class of work is largely designed by the manufacturer, and as a natural result is the duplicate of something already produced, whilst on the other side of the Atlantic the builder of the machinery works from the plans of the electrical engineer, which necessitates his producing something different to fill each different contract. In one case the machinery is really manufactured; in the other case the builder runs a jobbing shop. Unfortunately, during the last few years American users of electrical apparatus have somewhat departed from the pursuance of what is really a fundamental principle of American manufacture, namely, the use of existing types which are turned out in large quantities with special tools with a view to the lowest possible cost of production. The electrical engineer for the purchaser has been permitted to draw up specifications which have tended towards the specializing of apparatus, necessarily interfering with rapid manufacture and low cost of the product. The disadvantage to the manufacturer is apparent. It is turning our large electrical works from manufacturing establishments into jobbing shops, cutting down their capacity, increasing their labor cost, and lengthening the time that it takes to produce a given article. Looking at it, therefore, from the point of view of the manufacturer, the capacity of his plant is reduced and consequently his interest and general expense cost is higher; his labor cost is increased; and if he finds himself unable to increase his selling price, his shop must be run at a loss instead of at a profit.

The user is necessarily interested in low cost of production on the part of the manufacturer, as he cannot expect to purchase apparatus except at prices which yield a return to the maker. From this point of view alone it would seem to me to the interest of the user that he should co-operate with the manufacturer with a view to standardizing apparatus, eliminating unnecessary variations from a given type, and providing specifications for machinery calling for a given capacity at a given efficiency. Such a course would lead to low cost of manufacture and consequently low selling price, coupled with rapid production.

Another objection to special apparatus is the expense and delay in obtaining duplicate parts in case of breakdown. The fear of delay under such circumstances often necessitates the user carrying the duplication of his plant to a point entirely unnecessary when standard apparatus is used. Capital investment and consequently interest cost is thus increased, not only by the purchase of apparatus which of itself is expensive to build, but also by the duplication of investment which I have pointed out must of necessity follow.

A further point which should be borne in mind in connection with the lack of standard specifications is the opportunity that it gives to the unprincipled manufacturer to dispose of his second-rate apparatus to the uninitiated. We talk of a machine having a given capacity; but under what conditions should it operate to develop this capacity and how often does it occur that a dynamo machine is rated entirely too high and at the cost of its efficiency? How much miscellaneous material used in connection with the industry is absolutely unfitted for the purposes for which it is sold? Surely all of us, manufacturers and users, are interested in maintaining the highest possible standard of work and eliminating alike from our central station systems and the installations for our customers worthless appliances whose only recommendation is their apparent cheapness, whereas, as a matter of fact, they are really the most expensive that can be bought, because they are unfitted for the purposes for which they are intended. A proper consideration of this subject would not embrace alone the apparatus we are ourselves in the habit of buying for use in connection with our plants, but also the appliances used in connection with customers' house wiring. It should be borne in mind that faulty apparatus from one cause or another resulting in the stoppage of the service of one or more customers is, in the mind of the user of the current, set down to the unreliability of the system as a whole. A central station customer seldom discriminates between a contractor who supplies a worthless device and a company supplying him with current. Standard specifications should therefore cover not alone the machinery used, but also the devices and material forming part of a customer's installation. This association has addressed itself at various times to the consideration of questions in connection with house wiring and has co-operated with the National Board of Fire Underwriters and other bodies with a view to establishing rules to be followed by contractors. I strongly recommend that this matter be taken up on a broader basis than heretofore, and that in conjunction with the technical societies we invite the co-operation of the electrical manufacturers with a view to standardizing apparatus and the specifications therefor, whether for use in the central station itself or in connection with the distributing system.

I do not want my remarks on this subject to be taken as in any way censuring the many electrical engineers who have by their special training and natural ability done so much to develop the industry with which we are connected. From my experience I am satisfied, however, that, from the point of view of the user, the designing engineer who adapts his requirements to the standard apparatus of a first-class manufacturer, is able to produce a plant of more satisfactory character and more economical to operate than that designed by those engineers whom I regret to say are sometimes influenced by the desire to use machinery which they can claim as their own handiwork, rather than use something that would be quite as satisfactory and has the advantage of being the regular product of an established manufacturer.

The consideration of the subject of standard specifications would naturally include the preparation of specifications with relation to the manufacture of incandescent lamps. For several years past a committee of this Association has had the subject under consideration. It has been found practicable by a number of large central station companies connected with another association and buying from one manufacturer, to purchase their lamps under specifications which provide for the testing of samples of the product of the factory, the payment for lamps supplied being based on the results of the tests. It seems to me that it would be possible to adopt standard specifications under which our members could purchase their lamps from any reputable lamp manufacturer. The importance of this matter will be appreciated when it is remembered that the cost of lamp renewals per unit of output exceeds $1.00 per ton of the cost of fuel in operating a central station, with the most modern steam plant.

(To be continued.)

Sheffield, Ala.—The Kitson Hydrocarbon Heating & Incandescent System Co. has been incorporated by W. R. Brown, A. B. Cook, Jr.; B. B. Cohen and J. H. Nathan; to erect an electric light and heating plant. Capital stock, $5,000.

Fayetteville, N. C.—George A. Holderness and W. J. McDiarmid contemplate the establishment of a telephone system.

West Point, Miss.—C. L. Jordan, Mayor, may give information concerning proposed electric light plant.

New York, N. Y.—Bell Electric Co., manufacturers of electric bicycle lamps, 46 East Fourteenth street, attached by Deputy Sheriff Strauss for $300.

Buffalo, N. Y.—The La Salle Electrical Co. has been incorporated by Charles A. Pooley, Maurice C. Spratt and R. C. Palmer. Capital stock, $50,000.

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EFFECT OF ARMATURE INDUCTANCE UPON THE ELECTRO-MOTIVE FORCE CURVES OF AN ALTERNATOR.

(Continued from page 327.)

Counter Electromotive* Force Curves.

Having the instantaneous current and inductance curves corresponding to a series of loads on the machine, it was a comparatively easy matter to determine the curves of the counter electromotive forces developed in the armature. To obtain a curve showing the cyclic variation of the induction set up in the coils by the armature current, it is only necessary to plot the products of the ordinates of corresponding points on corresponding currents and inductance curves. Such a set of curves ob-

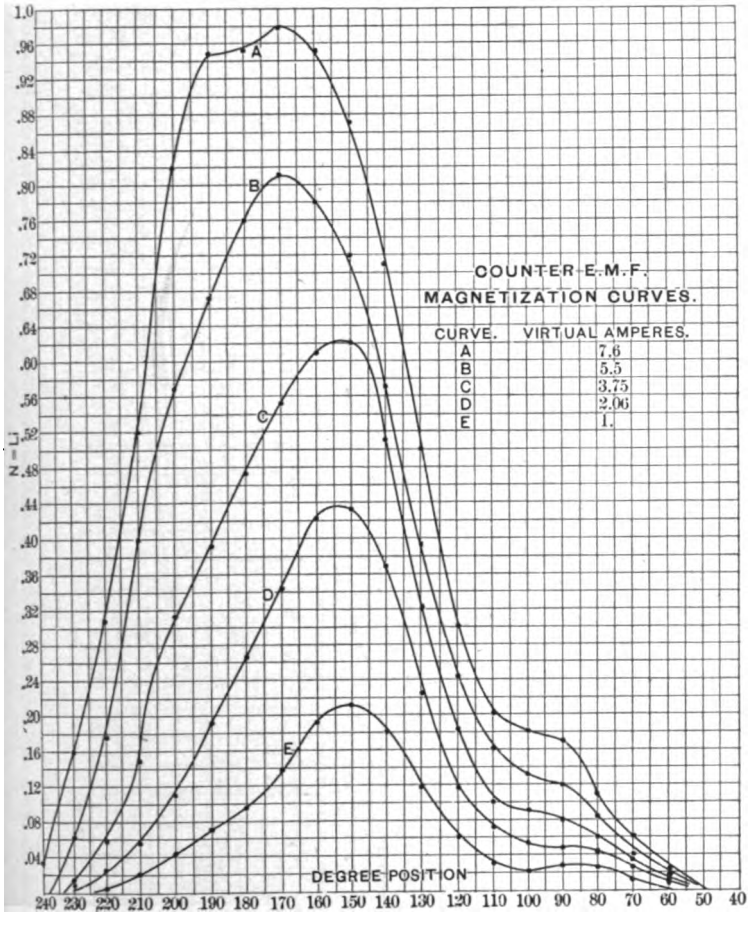

Plate 11.

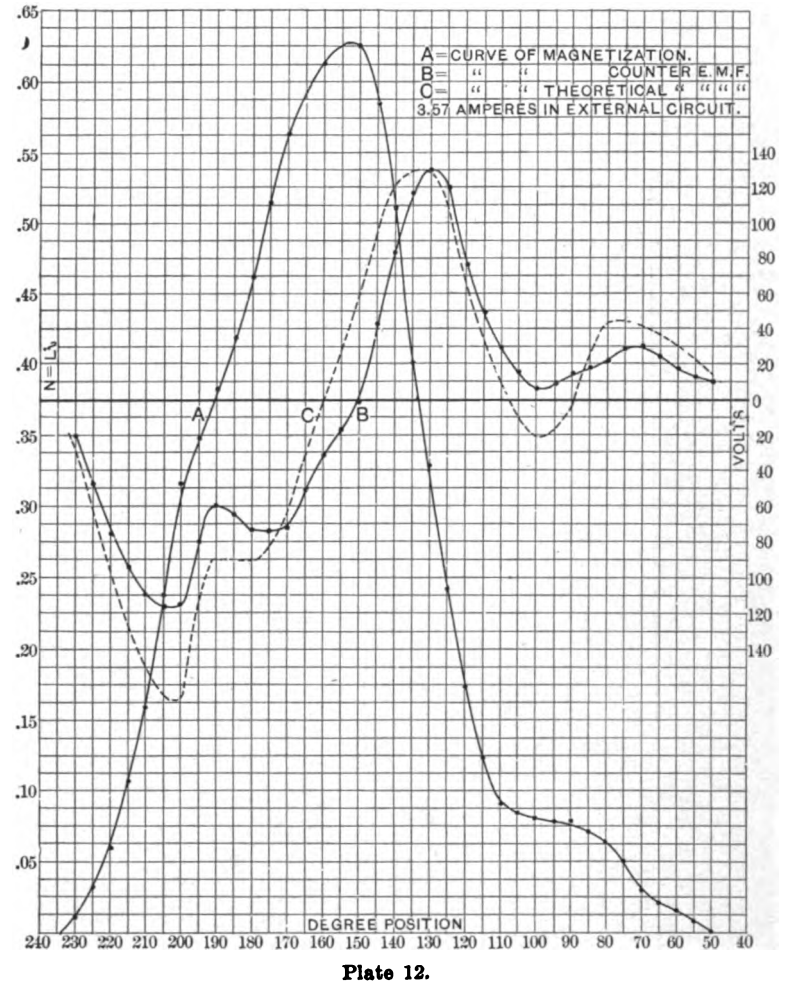

Plate 12.

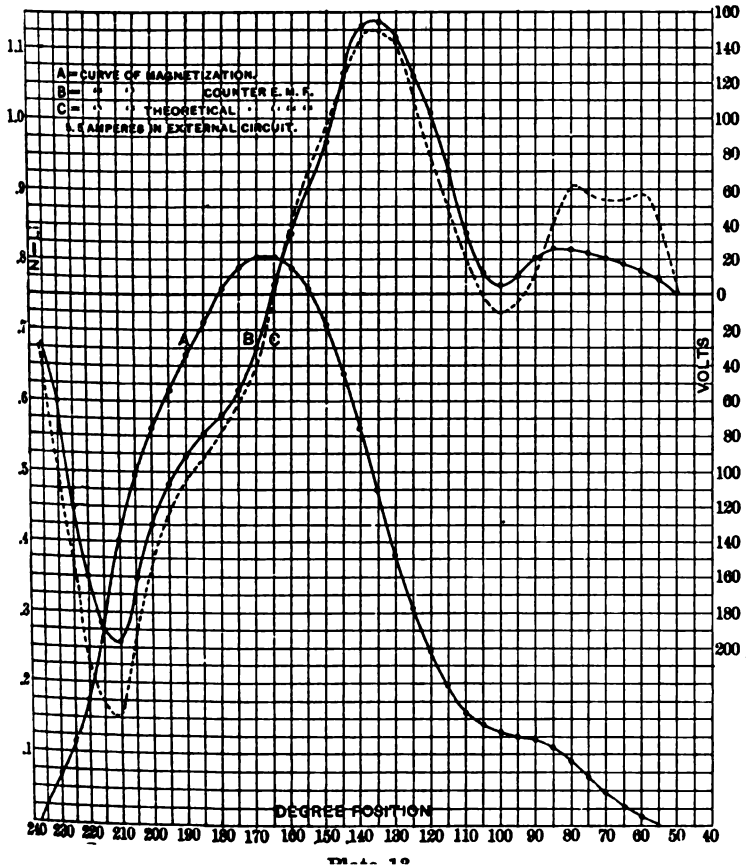

Plate 13.

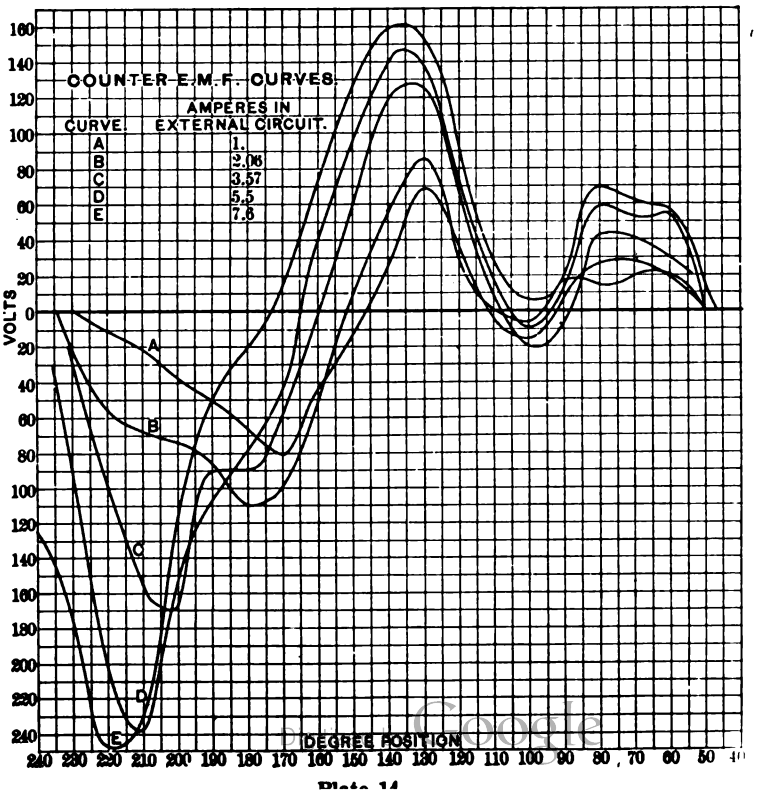

Plate 14.

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tained from a combination of the curves of Plates 9 and 10 are given in Plate 11.

If N represents the total flux that is induced in both coils by the armature current, divided by 10^8; L represents the inductance of the coils connected in series in henrys; S represents the total number of turns (572) of wire in both armature coils; and A represents 80 per cent. of the gross area of the armature core inside the coils, or 11 sq. cms.

Then the induction per sq. cm. in the coils due to the armature current will equal,

$$B = \frac{N \times 10^8}{S\,A} = 15892 \times N. \qquad (2)$$

In Plates 9, 10 and 11 we have the necessary curves for determining the instantaneous values of the counter electromotive force corresponding to any degree position by applying the principles underlying either of the above expressions. Both methods were used and were found to check within narrow limits. In Plates 12 and 13 the curves marked A have been taken from Plate 11. The ordinates of the curves marked B are equal to the tangents of the angles made with the horizontal axis by lines drawn tangent to the A curves at the extremities of corresponding ordinates. The B curves are the calculated curves of counter electromotive force developed in the armature. The dotted curves were obtained by subtracting curves D and E of Plate 6 from curve A of Plate

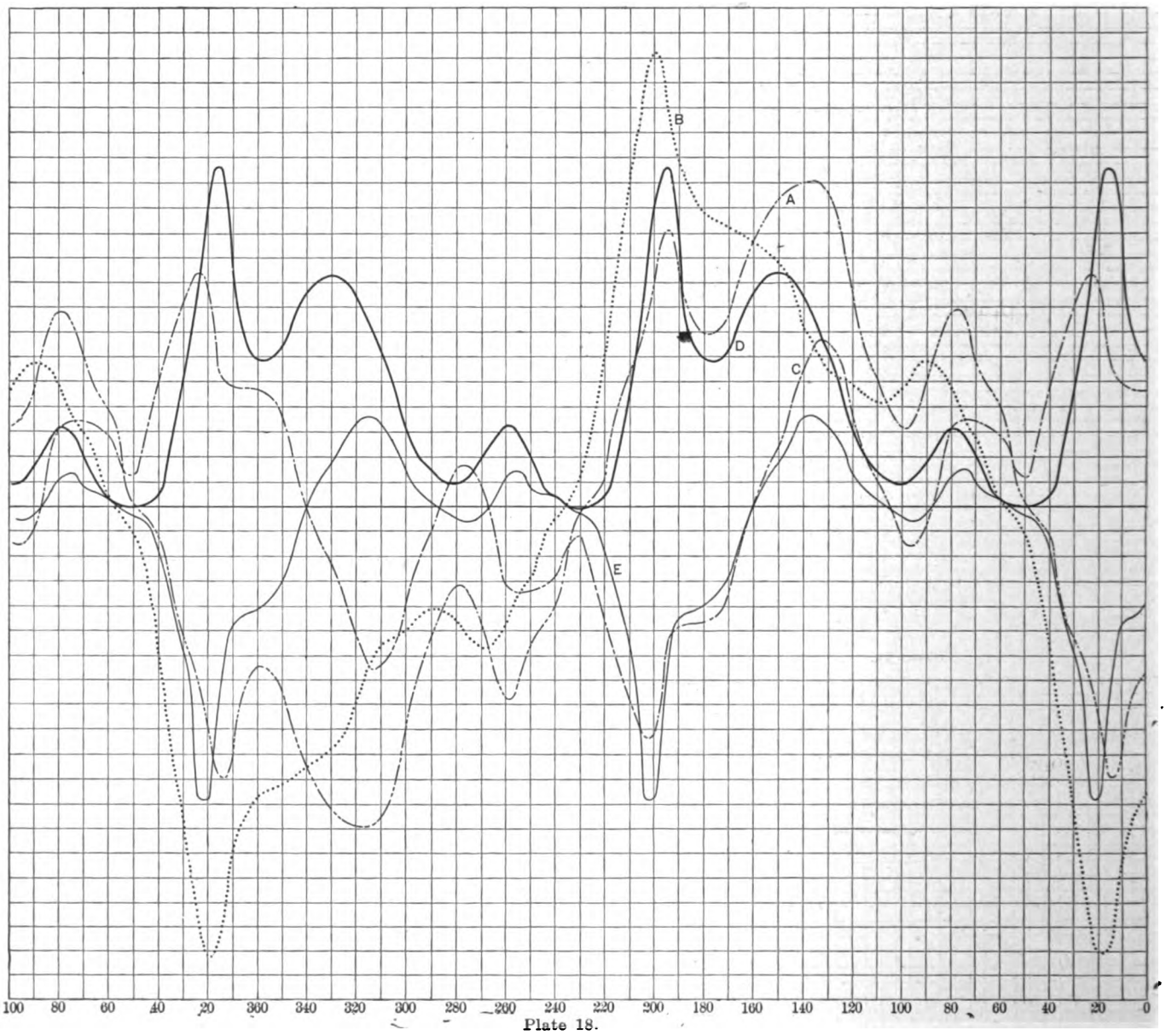

Plate 18.

This equation gives the constant (15892) that must be applied to the scale of ordinates in Plates 11, 12 and 13 to determine the actual core densities induced by the armature currents.

Again, if i represents the instantaneous value of the armature current,

$$N = L\,i \qquad (3)$$

and

$$d\,N = L \times d\,i + i \times d\,L, \qquad (4)$$

since L is a variable. Therefore, the counter electromotive force developed in the coils equals

$$e = -\left(-\frac{d\,N}{d\,t}\right) = \supset\left(L\frac{d\,i}{d\,t} + i\frac{d\,L}{d\,t}\right). \qquad (5)$$

6. On the assumption that the fundamental electromotive force wave of the machine does not change with the load, the dotted curve should also represent the counter electromotive force curve of the armature, and, in fact, the two curves should coincide.

Plate 12 represents the poorest, and Plate 13 one of the best, results obtained from the application of this construction to each of the five sets of curves taken from the dynamo. When the fact is taken into account that the inductance of the coils was determined when the armature was at rest, the likeness between the dotted and the full curves is quite remarkable, and apparently justifies

(Continued on page 347.)

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MEMBERS AND GUESTS AT N. E. L. A. CONVENTION.

Badger, F. H., Jr., Montmorency Electric Power Company, Quebec, Canada; Badt, F. B., Meysenburg & Badt, Chicago; Baird, M. E., Eddy Electric Manufacturing Company, Windsor, Conn.; Baker, C. O., Anchor Electric Company, Chicago; Baker, C. O., Jr., Baker & Co., New York; Barker, F. E., Massachusetts Gas and Electric Light Commission, Boston; Barr, Edward L., W. R. Brixey, Chicago; Barron, A. M., Home Electric Light and Power Company, Elkhart, Ind.; Bean, W. Worth, Jr., St. Joseph and Benton Harbor Electric Railway and Light Company, St. Joseph, Mich.; Beetle, George L, Western Electric Company, Chicago; Bement, A., Bement & Co., Chicago; Benton, C. A., Sprague Electric Company, New York; Blum, A. J., American Carbon Company, Fremont, O.; Boettcher, C., Imperial Electric Light Company, St. Louis; Booker, S. G., Phœnix Carbon Manufacturing Company, St. Louis; Bowen, G. S., Elgin, Ill.; Bradley, J. M., Birmingham Consolidated Electric Company, Birmingham, Ala.; Brinckman, E. S., Imperial Electric Light Company, St. Louis; Brooke, W. M., Electric Appliance Company, New Orleans, La.; Brooks, F. A., Charleston T.-H. Electric Company; Charleston; Brooks, H. H., American Circular Loom Company, Boston; Brooks, J. W., Brooks Follis Electrical Corporation, San Francisco; Brown, C. E., Central Electric Company, Chicago; Burleigh, J. J., and wife, Atlantic Electric Light and Power Company, Camden, N. J.; Burns, P. C., American Electric Telephone Company, Chicago; Butler, W. W. S., Milton Electric Light and Power Company, Milton, Pa.

Candee, Willard L., Okonite Company, New York; Carnes, S. T., Memphis Light and Power Company, Memphis, Tenn.; Carr, R. F., Dearborn Drug and Chemical Works, Chicago; Cate, George W., Edison Illuminating Company, Detroit, Mich.; Channon, H. O., Quincy, Ill.; Clark, Frank H., Electric Storage Battery Company, Chicago; Clisdell, Percy A., General Electric Company, Minneapolis, Minn.; Coggshall, H. F., Fitchburg Gas and Electric Light Company, Fitchburg, Mass.; Coleman, Chas. E., Eugene Munsell & Co., Chicago; Collins, L. W., Leecol Storage Battery Company, Chicago; Comstock, C. G, Smith-Hill Elevator Company, Quincy, Ill.; Comstock, L. K., Western Electric Company, Chicago; Condit, Sears B., L. A. Chase & Co., Boston; Cooke, J. H., Buckeye Electric Company, Chicago; Cooper, Thomas, Pekin Electric Light and Power Company, Pekin, Ill.; Copeland, F. A., Edison Light and Power Company, La Crosse, Wis.; Crandall, C. D., Western Electric Company, Chicago; Cravath, J. R., Chicago; Crawford, Ronald, Stamford Gas and Electric Company, Stamford, Conn.; Creden, T. H., Chicago Edison Company, Chicago; Crider, J. S., Washington Carbon Company, Pittsburg, Pa.; Crossman, T. E., official stenographer, New York; Crouse, J. B., Crouse-Tremaine Carbon Company, Fostoria, O.; Crowell, H. H., General Electric Company, Syracuse, N. Y.; Culver, J. H., Culver Electric Company, Decatur, Ill.; Cummings, James F., Armorite Interior Conduit Company, Pittsburg, Pa.; Cunningham, J. W., Capital Electric Light, Motor and Gas Company, Boise, Idaho; Cushing, L. K., Illinois Electric Company, Chicago; Cutler, Harry H., Cutler-Hammer Manufacturing Company, Chicago; Cutter, Henry B., and wife, Cutter Electrical and Manufacturing Company, Philadelphia.

Dale, John H., Dale Company, New York; Daniels, A. L., the H. B. Camp Company, North East, Pa.; Davis, Ernest H., Lycoming Electric Company, Williamsport, Pa.; De Camp, A. J., Brush Electric Light Company, Philadelphia; Dee, A V., Philadelphia; Dee, James R., Peninsula Electric Light and Power Company, Houghton, Mich.; Dickey, Edmund, American Carbon Company, Noblesville, Ind.; Doan, J. P., Jacksonville Gas Light and Coke Company, Jacksonville, Ill.; Doherty, H. L., Madison Gas and Electric Company, Madison, Wis.; Donohoe, F. E., American Electrical Works, Chicago; Dow, Alex., Mutual Electric Light Company, Detroit, Mich.; Downes, L. W., D. & W. Fuse Company, Providence, R. I.; Downs, B. B., Electric Appliance Company, Minneapolis; Drake, C. F., Fort Scott Electric Light and Power Company, Fort Scott, Kan.; Dull, P., Milledgeville, Ill.; Dysterud, E., Electric Light Company, Monterey, Mex.

Ebert, J. W., Western Electric Company, Chicago; Eddy, Charles M., Dearborn Drug and Chemical Works, Chicago; Edgar, H. T., Jandus Electric Company, Boston; Ely, J. H., Georgia Electric Light Company, Atlanta, Ga.; Engel, W. T., Charlotte Electric Company, Charlotte, N. C.

Fakes, J. G., Oklahoma City, O. T.; Ferguson, Louis A., Chicago Edison Company, Chicago; Ferguson, James, Municipal Electric Light Company, Brooklyn, N. Y.; Ferris, Thomas, General Electric Company, Milwaukee, Wis.; Field, C. J., Port Jervis Electric Railway and Light Company, New York; Field, A. W., Columbus Edison Electric Company, Columbus, O.; Finney, W. E., Chicago Edison Company, Chicago; Floy, Henry, Westinghouse Electric and Manufacturing Company, Minneapolis, Minn.; Foster, George B., Walker Company, Chicago; Frank, Jacob, Cosmopolitan Electric Company, Chicago; Fraser, R. H., Des Moines Edison Light Company, Des Moines, Ia.; Frith, Harry J., Watseka Electric Light Company, Watseka, Ill.; Fujioka, I., Japan Electric Light Association, Tokyo, Japan.

Gage, Channing T., Washburn & Moen Manufacturing Company, St. Paul, Minn.; Gardner, J. W., Stirling Company, Chicago; Garrison, A. C., Columbia Incandescent Lamp Company, St. Louis; Garton, W R., Chicago; Gates, J. Holt, Walker Company, Chicago; Gilbert, L. H., Jonesville Electric Light and Power Company, Jonesville, Mich.; Gille, H. J., Edison Electric Light and Power Company, St. Paul, Minn.; Gilmer, Elmer W., Warren Electric and Specialty Company, Warren, O.; Goldsborough, W. E., professor in Purdue University, Lafayette, Ind.; Greenwood, C. H., Edison Light and Power Company, La Crosse, Wis.; Gregory, John M., City Electric Light, Bellefontaine, O.; Grier, Edward R., Bryant Electric Company, Chicago.

NEW ELECTRICAL INCORPORATIONS AND BUSINESS CHANGES.

Galva, Ill.—Galva Telephone Co. has been incorporated by Geo. D. Palmer, L. H. Johnson and W. A. Wigen; to conduct a telephone business. Capital stock, $2,000.

Decatur, Ill.—Electric Supply and Fixture Co. has been incorporated by C. E. Gibson, G. B. Marshall and R. H. Coleman; to manufacture electric supplies. Capital stock, $2,500.

(Continued from page 346.)

the assumptions that have been made. The counter electromotive force curves are highly irregular in form. They oscillate from the positive to the negative value twice in a period instead of once, and are generally useful in filling up gaps. As shown, the curves represent the halves of one of the positive and one of the negative loops; in other words, the half period of the curves lies between the 350° and 170° positions, and not between the 50° and 230° positions. This will be made more evident by a reference to curve C of Plate 18.

The whole series of inductance curves, as obtained by the subtraction method, are plotted in Plate 14. This assemblage shows that the curves follow one another in regular order in spite of their lack of symmetry, and it is interesting to note the receding of one and the building up of another "hump" in these curves, as illustrated at the lower left-hand edge of the sheet.

(To be Continued.)

*In this paper the term "counter E. M. F." is used to indicate the E. M. F., which, added to the effective E. M. F., will equal the fundamental E. M. F. The counter E. M. F. is therefore equal and opposite to the inductance E. M. F., or the E. M. F. of self-induction.

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Carrollton, Ohio.—The Carroll County Telephone Co. has been incorporated by Union C. De Ford, H. J. McGranahan, J. C. Patterson, A. L. Iden and Simeon Ashbrook. Capital stock, $10,000.

Anderson, Ind.—Postal Telegraph Co. has been incorporated by Leander B. Parker, Ed. J. Wally, W. I. Chapin, Frank W. Samuels, Ed. Wallardt and John F. Looney. Capital stock, $5,000.

Conneautville, Pa.—Conneautville Telephone Co., of Crawford County, has been incorporated by R. F. Wilcox, L. D. Carey, J. H. Smith, I. T. Snodgrass, W. J. Darby, D. E. Hewitt. Capital stock, $4,500.

Victoria, Tex.—The Mayor may be addressed concerning proposed electric light plant, etc.

Thibodaux, La.—The Cumberland Telephone Co. has obtained franchise to construct and operate a telephone system.

Brenham, Tex.—The Brenham & Shelby Telephone Co. has been incorporated by T. A. Low, Sr., Robert Strickert, A. D. Wilroy, Ben Schmidt and B. E. Witte; for the purpose of constructing and operating a telephone system between Brenham and Shelby. Capital stock, $1,000.

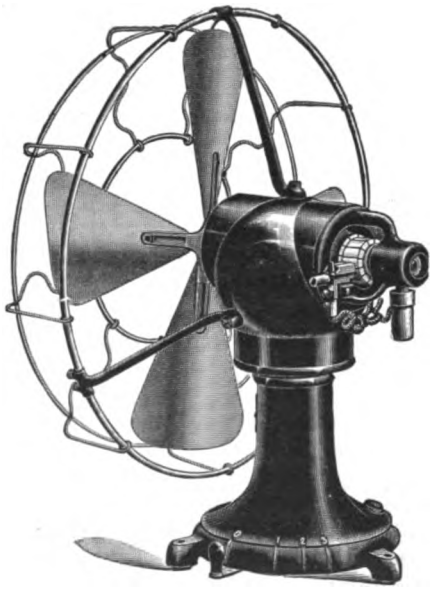
Uvalde, Tex.—The Uvalde Water, Ice & Electric Co. will shortly commence work on proposed electric light plant. Plant is to have one arc and 350 incandescent lamps.

St. Marys, W. Va.—The McKin Telephone Co. has been organized with R. H. Browse, President; L. A. Ellis, Secretary, and Arlando Eddy, Treasurer.

Manor, Tex.—The Manor Artesian Well Co. will establish an electric-light plant.

1898 "HURRICANE" FAN MOTOR.

The direct-current fan motors manufactured by C. A. Eck have been well introduced by the firm of Goldmark & Wallace, 221 Worth street, New York. These motors are very compact and operate noiselessly. They are of



1898 "Hurricane" Fan Motor.

the consequent pole type, the self-aligning phosphor bronze bearings, exposed and easily adjusted brushes, and a commutator of substantial construction and ample cross section to each segment. The bearings are provided with an oil-box to prevent spraying. The armature is toothed and runs cool at full speed. The efficiency of this motor is very high, as its magnetic and electric design is excellent.

A switch throws in three speeds and the current required for the twelve-inch, 110-volt is thirty-five hundredths of an ampere; for the sixteen inch 110-volt, is fifty-five hundredths of an ampere. The speed of the one-eighth horse-power is 900, 1400 and 1800 revolutions per minute; of the one-sixth horse-power, 800, 1200 and 1600 revolutions per minute. These fans produce a uniform and powerful breeze without vibration of any description and serve the purpose for which they were intended with high economy and perfect satisfaction.

To supply the Army and Navy of the United States, now expanded to a war footing, very large demands are being made on the American Bible Society for pocket Testaments. Tens of thousands of copies have been called for by the chaplains of regiments, Young Men's Christian Association officers and other responsible parties who are at work in the camps all over the country and at the front. Care is used to insure the wisest distribution, accompanied by a friendly word with each man. Deprived as they are of reading matter, they gladly accept the books and will treasure them as a souvenir of the war.

Our brave boys in blue who are exposing their lives for country and humanity are exposed also to the passions and demoralizing influences of war. It is a sacred and potriotic duty to equip them with "the sword of the Spirit which is the Word of God."

In order that the American Bible Society may be able to grant these great and unexpected requests, gifts large and small from individuals and churches should be sent at once direct to

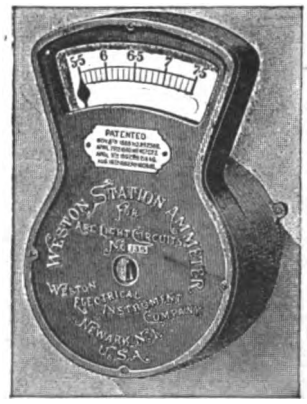
William Foulke, Treasurer,
Bible House, New York City.

SOME ELECTRIC SHOW NOTES.

The Partridge Carbon Co. exhibited under the supervision of Wood, Shaw & Co. the various kinds of self-lubricating carbon and pure plumbago dynamo and motor brushes, in addition to their new arc light carbons, which are said to be equal to the imported.

Among the various exhibits at the Electrical Show that of J. JONES & SON, 64 Cortlandt street, New York, dealers in electrical supplies of all descriptions, was one of the most popular and attractive.

MR. DANIELS exhibited H. B. CAMP & COMPANY'S cement electrical ducts or conduits. The writer saw a lot of this duct being installed in Brooklyn last week. They say they have millions of feet in use in Greater New York.



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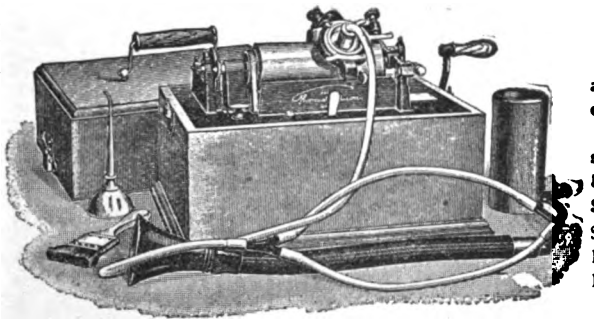

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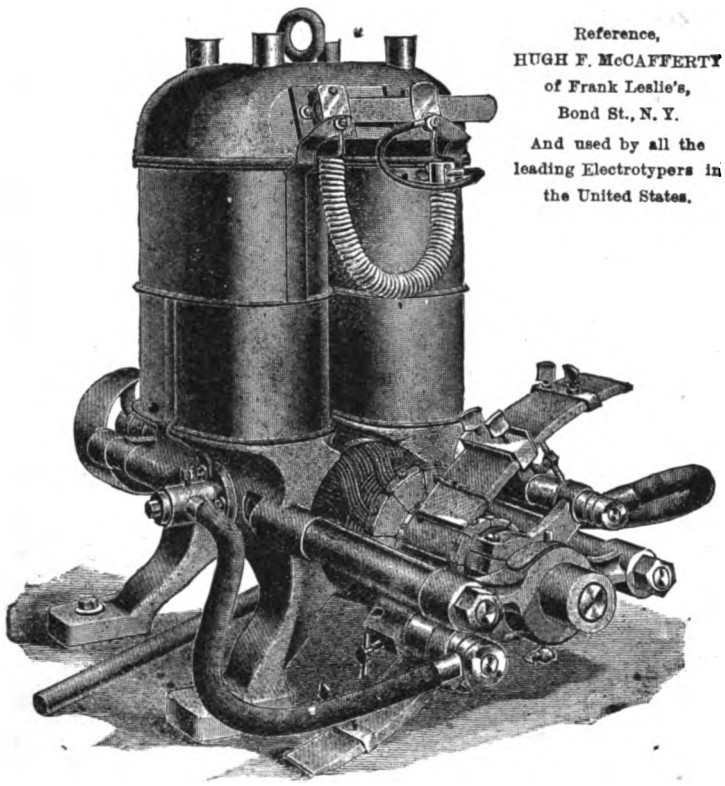

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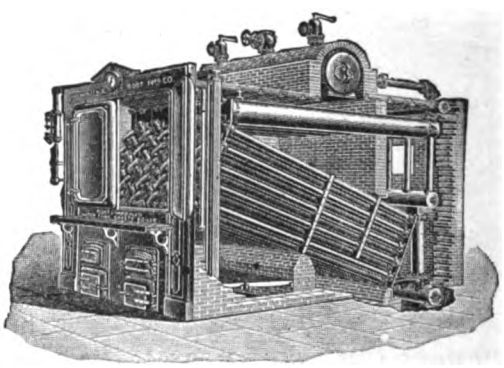

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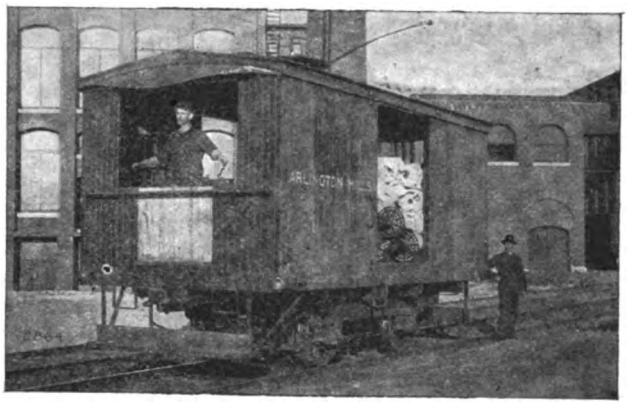
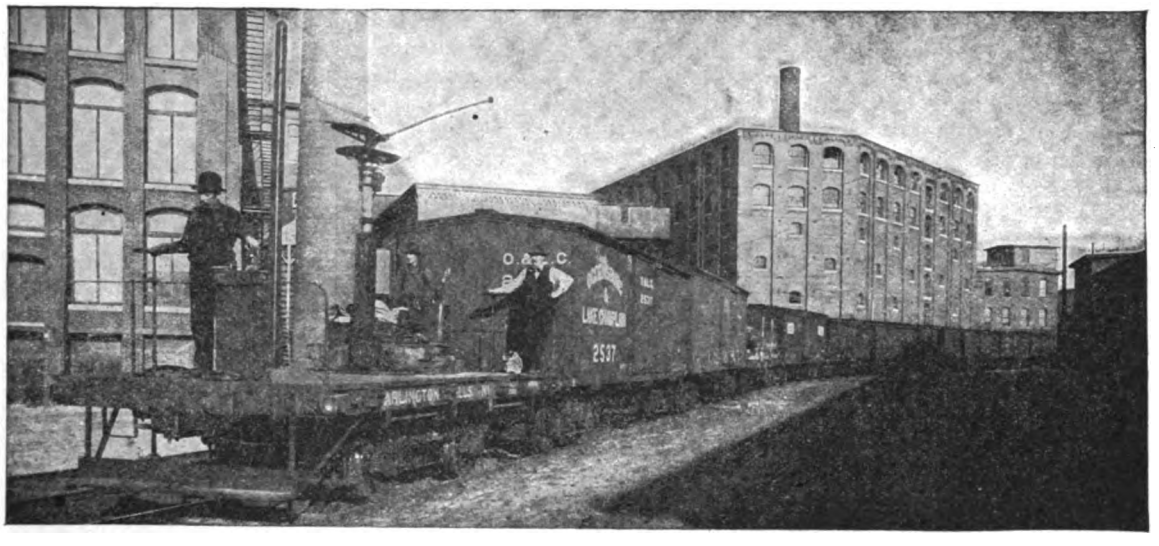
The Electrical Age.

VOL. XXI—No. 26 NEW YORK, JUNE 25, 1898 WHOLE No. 580



General Electric Box Car Locomotive, Arlington Mills.



G. E. Platform Locomotive Hauling a Train, Arlington Mills.

ELECTRICITY VERSUS STEAM.

A striking instance of economy in actual money and elimination of trouble and delay induced by supplanting a steam haulage service with electric traction is offered by the installation recently made by the General Electric Company for the Arlington Mills, Lawrence, Mass. These mills have about two miles of track running from the main line of the Boston and Maine Railroad into the yards and throwing off spurs into the alleys between the different buildings. Previous to the change to electrical service, the haulage of the entire output of the mills to the main line, the haulage of the material from building to building, as well as the necessary switching about the yards, was done by a steam locomotive rented from the railroad. For this service the Arlington Mills paid an annual rental of several thousand dollars, and were, moreover, frequently put to great inconvenience and delay on account of the unavailability at times of any locomotive.

The successful results obtained with electric factory locomotives by other mills in New England, notably at Whitinsville, Mass., and Taftville, Conn., attracted the attention of the managers of the Arlington Mills to the question of electric haulage, which they took into serious consideration. As every case in which electric traction has been adopted in factories showed an improved service, as well as an actual money economy, electricity as a motive power was decided upon.

The electrical installation consists of a small generating plant and two electric locomotives, one of the box type and the other a platform car. The generating plant consists of a standard G. E. 75 k.w. 500-volt railway generator driven by belt from an Armington & Sims high-speed engine. The generator readily answers all calls upon it, with absolutely no heating or sparking, although it is occasionally subjected to very heavy overloads when both cars are handling a train of more than the usual number of loaded cars.

The box-car locomotive used for hauling material about the yards is shown in Fig. 1, and is equipped with two G. E. 800-27 H. P. motors and series parallel controllers. The platform locomotive is used to haul trains of loaded cars from the yards to the main line, and empties from the line to the mill tracks, and to do all the drilling in the yards. The equipment of this locomotive consists of two 50 H. P. G. E. 1200 motors with the necessary series parallel controllers. In hauling heavy trains it is assisted by the box-car locomotive. Together they are able to handle trains of 30 to 40 empties, or 12 to 14 loaded cars, with comparative ease and celerity. To give the necessary adhesion to the more powerful locomotive to enable it to handle heavy loads, about six tons extra weight is placed on the platform.

Perhaps the most interesting feature is the comparison between the cost of the electric plant and the expense

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formerly entailed by the use of the superseded steam locomotive. The cost of the entire electric plant was very little in excess of one year's rental of the steam locomotive. No more men are employed about the electric locomotive, the labor and cost has not risen, and the consumption of coal is scarcely felt on the main plant. Furthermore, the plant being always ready, cars may be shifted at any time during the day or night.

The new system is thus both economical and advantageous, and the appreciation of the Arlington Mills is, perhaps, best shown by the fact that a second platform locomotive is shortly to be added to this haulage plant.

DEVELOPMENT OF ELECTRICAL SCIENCE.

(Concluded.)

In 1887 the theory was advanced by Arrhenius and Ostwald that dissociation is directly effected by solution or fusion and that in very dilute solutions the dissociation is practically complete. Arrhenius holds that the ions carry charges of electricity, positive or negative, dependent upon their nature, but of equal quantity in every ion. The remaining part of the theory is similar to that of Clausius and others. According to this theory, the ratio of electric conductivities for different densities of solution gives a measure of the relative dissociation or ionization. If the act of solution effects the dissociation necessary to admit of electrolysis, chemically pure substances ought not to be decomposed by the electric current, and this is found to be the case. It is curious that two substances like hydrochloric acid and water, which, separately, are insulators, should, when mixed, conduct readily, and that practically only one of them should be decomposed. This, however, is only one of the many problems still to be solved. Another question is, how do the ions obtain their electric charge? Still another, what is the nature of the force which causes ionization? There are many more.

When we turn to the commercial application of electrochemistry we are met with astonishing evidence of activity. Only twenty years ago there was comparatively little evidence of the importance of this branch of applied electricity. At the electrical exhibition in 1881 electrochemistry was apparently of comparatively little prominence. A factory which could produce a few hundred tons of copper electrolytically was considered a wonder. The production of thousands of tons a month is beginning to be looked upon as commonplace. There is scarcely a metal which cannot be deposited electrolytically with comparative ease, and the prices of some of the rarer metals are going down rapidly. Zinc used to be considered a difficult metal to deposit successfully. It is now produced in some of the Australian mines in almost a pure state from refractory ores at the rate of thousands of tons per annum. Similarly the old method of galvanizing is rapidly disappearing and electro-deposition is taking its place, and this metal is now so deposited on the hulls of ships, on anchors and other smaller articles cheaply and perfectly. A new industry has practically sprung up, and there is every indication that the technical chemist of the near future will have to take an inferior place unless he be also well-versed in electricity and electrical appliances. This branch of applied science is revolutionizing many things. It has within a few years produced an enormous improvement in our magazine illustrations, and has, at the same time, reduced the cost of this kind of literature and of atlases and charts enormously.

Electro-chemistry is now used on a large scale for the production of chlorate of potash, bleaching materials, alkalies, coloring matters, antiseptics, like iodoform, anæsthetics, like chloroform, etc. In fact, it is getting to be difficult even to enumerate the manufactures in which it is used. It has revolutionized the extraction of gold, and plants of enormous capacity are now in use in some of the gold fields, the poorest ores and tailings being made to yield up almost the last trace of the precious metal. The production of ozone by the ton, the purification of sewage and the sterilization of water are all accomplished facts.

Some progress has even been made in the introduction of chemicals through animal tissues by electrolysis or cataphoresis, and Rœntgen has shown us how to see through the body.

Then, again, we have got the electric furnace, and with it the power to fuse almost the most refractory substances. In this way aluminum is now produced at a few cents a pound, whereas most of us remember when its price had to be reckoned in hundreds of dollars. In a similar way phosphorus is now produced on a large scale, as are also various carbides, carborundum, acetylene, etc.

It is impossible to look back over the history of electricity and its applications and notice the apparent geometric ratio in which advances are being made, and not to speculate on what a giant this science is going to become in another quarter of a century. Undoubtedly no one can study this one branch of science without being persuaded of the great value of scientific work for the advancement of human enterprise.

THOMAS GRAY.
ROSE POLYTECHNIC INSTITUTE.

CANADIAN ELECTRICAL ASSOCIATION.

The eighth annual convention of the Canadian Electrical Association will be held in the Windsor Hotel, Montreal, on June 28th, 29th and 30th, 1898; and the annual banquet at the Windsor Hotel, Wednesday evening, June 29th, 1898, at 9 o'clock. John Yule, President; C. H. Mortimer, Secretary.

Business Programme.

Tuesday, June 28th.

9:30 a. m. Meeting of the Executive Committee.

10:00 a. m. Opening of first session in Convention Hall, Windsor Hotel.
President's Address.
Reading Minutes of last Meeting.
Secretary-Treasurer's Report.
Reports of Committees and General Business.

2:00 p. m. General Business.
Presentation of Papers.
Discussion.

Wednesday, June 29th.

9:00 a. m. Consideration of Reports of Committees.
Election of Standing Committees.
Selection of Place and Time of next Meeting.
General Business.
Presentation of Papers.
Discussion.

Thursday, June 30th.

9:30 a. m. Election of Officers.

List of Papers.

"How to Overcome Some of the Difficulties Encountered by Central Station Men."
A. A. Wright, Renfrew, Ont.

(1) "The Unconscious Ownership of an Important Key"—(A Plea for the Introduction of Goods Traffic on Our Suburban Tramways).

(2) "The Quimby Screw Pump."
W. T. Bonner, Montreal.

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"Experiences of an Inspector."
Dr. J. K. Johnstone, Inspector of Electric Light, Toronto.

"The Electric Current in the Rainy River Gold Mines."
M. W. Hopkins, B. Sc., C. E., etc.

"The Importance of Proper Methods of Illumination."
F. A. Bowman, M. A., B. E., New Glasgow, N. S.

"Electric Utilization of Water Powers."
Louis DeWitt Magie, Montreal.

"Economies in the Boiler Room."
James Milne, Toronto.

Social Features.

Tuesday, June 28th.

7:30 p. m.—Trip around Mount Royal by special Park and Island cars, afterwards ascending Incline Railway to lookout on mountain to view the city under illumination.

Wednesday, June 29th.

1:00 p. m.—Visit to (1) Bell Telephone Company's new building; (2) Street Railway Company's power house; (3) power house and works of the Lachine Rapids Hydraulic & Land Co., returning to city at 7:30 p. m.

9:00 p. m.—Annual Association Banquet at Windsor Hotel.

Thursday, June 30th.

11:00 a. m.—Visit to McGill University.

1:30 p. m.—Visit to Royal Electric Company's lighting station and factory; then by special G. T. train to visit the works of the Chambly Manufacturing Company at Chambly.

Canadian Electrical Association Convention,

Montreal, 1898.

Reception Committee—Wm. Thompson, Chairman.

J. R. Thibadeau, S. T. Willet, H. H. Holt, C. R. Hosmer, Wm. Mann, F. L. Wanklyn, L. A. Herdt, A. Hadrill, P. W. St. George, W. H. Browne, John Carroll, O. Higman, R. E. T. Pringle, W. B. Powell, J. A. Baylis, W. S. Weldon, A. Aubin, Jules Bourbonniere, Donald S. Barton, E. Craig, H. O. Edwards, Robert Dobie, H. H. Henshaw, L. D. W. Magie, N. W. McLaren, Fred. Thomson, George Rough, W. H. Winter, J. E. Scott, F. W. Fairman, D. Ross Ross, George B. Burland, L. J. Forget, C. F. Sise, W. Dale Harris, W. G. Turner, D. McDonald, J. P. Mullarkey, A. Brunet, F. H. Badger, Sr.; L. B. McFarlane, G. W. Sadler, A. B. Smith, W. T. Bonner, F. H. Badger, Jr.; D. W. McLaren, W. McLea Walbank, F. W. Atkinson, Edward Butler, John Cunningham, P. J. Darlington, W. F. Dean, P. G. Gossler, W. E. Gower, R. A. Ross, F. J. E. Schwartz, Clarence Thomson, R. S. Kelsch, W. F. McLaren, C. E. A. Carr, J. J. York.

EFFECT OF ARMATURE INDUCTANCE UPON THE ELECTROMOTIVE FORCE CURVES OF AN ALTERNATOR.

(Continued from page 347.)

Plate 15 represents another phase of the subject. The curves traced in the fine black lines are the results of adding the calculated electromotive force curves determined by the means illustrated in Plates 12 and 13* to the corresponding effective or external electromotive force curves of Plate 6. They show the result of an attempt to work back from the effective electromotive force curves, or from the wave form of electromotive force appearing at the collector rings when the machine is loaded, to the fundamental electromotive force wave or the electromotive force wave appearing at the collector rings when the machine is running on open circuit.

The curve A, reproduced on this plate for comparison with the curves just mentioned, is the same as curve A of Plate 6. The agreement between the curves is marked. The derived curves show the greatest departure from the fundamental curve early in the cycle, between the 70° and the 110° positions. This is due to the fact that the initial "hump" at the 90° position of the induction curves was not developed with sufficient care. A very slight change in the contour of the induction curves at this point makes a great difference in the form of the counter-electromotive force curves, owing to its effect in altering the direction of the tangents drawn to the magnetization curves on Plate 11. On the whole, the likeness between the curves is well within the limits of the errors of observation.

Derivation of Current Curves.

Another interesting set of curves is shown in Plate 16. The success attained in working out the counter-electromotive force curves led to a series of calculations to determine to what extent the form of the current curves was influenced by the shifting of the phase of the inductance curves with the load. To this end an average of the inductance waves A, B, C, D, and E of Plate 3 was taken to represent the average inductance wave of the armature for all loads. This curve is shown as curve B of Plate 16. With this curve and the fundamental electromotive force wave A, forming a basis for calculation, the current that will flow with any given resistance in the circuit can be readily determined, provided that the curve B is taken to represent all of the variations that occur in the armature inductance.* The relation existing between the impressed electromotive force, the current and inductance in any alternating current circuit similar to the one under discussion is expressed by the equation

$$e = R i + \frac{d N}{d t}, \qquad (6)$$

There e, i and $\left(\frac{2 N \times 10^8}{S}\right)$ are, respectively, the instantaneous values of the impressed potential, current, and the magnetic flux induced by the current, and R is the resistance of the circuit.

Since $N = L i$, as above (see equation 1), in the present case we have:

$$e = R i + L \frac{d i}{d t} + i \frac{d L}{d t}. \qquad (7)$$

Then,

$$i \left(R + \frac{d L}{d t}\right) = e - L \frac{d i}{d t}, \qquad (8)$$

and

$$i = \frac{e}{\left(R + \frac{d L}{d t}\right)} - \frac{L}{\left(R + \frac{d L}{d t}\right)} \times \frac{d i}{d t}. \qquad (9)$$

By applying this formula to the curves of Plate 16, and following out a graphical construction, the successive instantaneous values of the current were finally determined, although in accomplishing this result the current curve E, which was the outcome of the process, had to be carried through successive cycles until it repeated itself.

The values of $\left(\frac{d L}{d t}\right)$ were taken from curve B,

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The ordinates of the curve A were then divided by the corresponding values of $R + \frac{dL}{dt}$, and these quotients, when plotted, gave the curve E.

Next, referring still to Plate 16, a point, as, for instance, p, was taken, that was thought to lie near the current curve, and the line $(p' r')$ was drawn. From (r') the line

$$(r' s') = \frac{L}{R + \frac{dL}{dt}} \qquad (10)$$

was laid off and $(s' p')$ drawn. Now from the assumed position of p',

$$\frac{p' r}{r' s'} + \frac{p' r'}{\left(\frac{L}{R + \frac{dL}{dt}}\right)} = \frac{di}{dt}, \qquad (11)$$

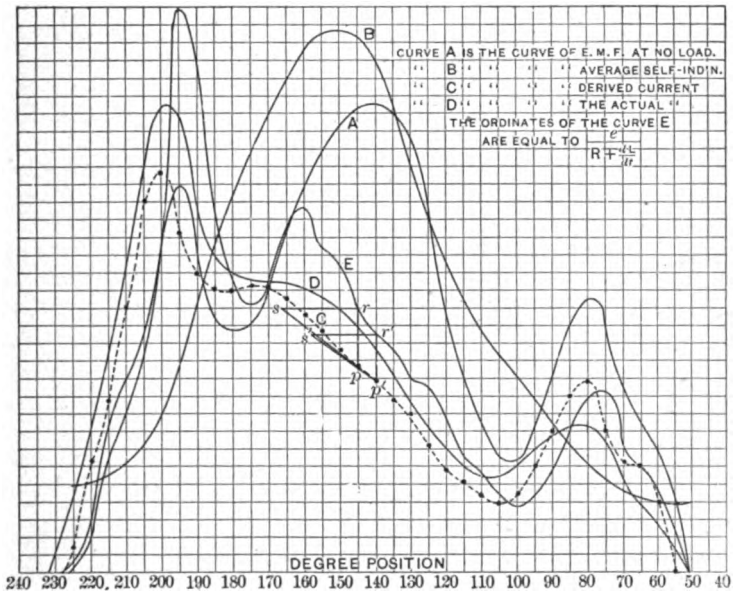

Plate XVI.

* Cuts were published in previous articles.

and $(p' s')$ established the direction of the current curve, since from equation (9),

$$\left(\frac{L}{R + \frac{dL}{dt}}\right) \frac{di}{dt} = \frac{e}{R + \frac{dL}{dt}} - i, \qquad (12)$$

and

$$\frac{di}{dt} = \frac{\frac{e}{R + \frac{dL}{dt}} - e - i}{\left(\frac{L}{R + \frac{dL}{dt}}\right)} \qquad (13)$$

and therefore,

$(p' r')$ approximated the value of $\frac{e}{R + \frac{dL}{dt}} - i.$ (14)

By taking another point p on $p' s'$, and continuing the construction, a chain made up of short lengths $p' p$ was obtained which ultimately developed into the periodic wave C, for which the values of

$$p' r' = \frac{e}{R + \frac{dL}{dt}} - i. \qquad (15)$$

The graphical construction used is not new. It is an adaptation of one of Dr. Sumpner's† unique methods of treating alternating current problems, and I have developed it here simply as a matter of interest in connection with the discussion.

Returning to the curves, it is noticeable that the dotted curve C resembles the current curves of Plate 9 very closely. Comparing it with curve D, which is a current curve taken from the machine, with 55 ohms resistance in the complete circuit, the chief difference noticed is that the right hand peak of the dotted curve is a little

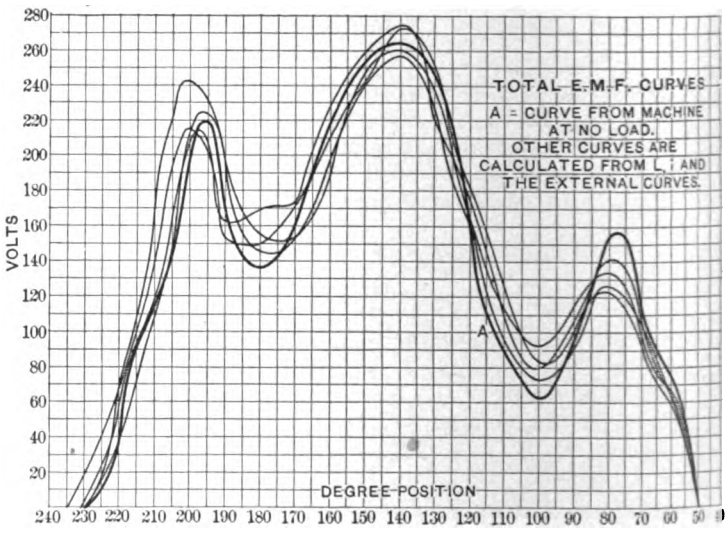

Plate XV.

high, and the left hand peak a little low, and that the curve as a whole is somewhat depressed below the curve D. The differences between the curves are, however, not very marked. They result largely from the curve B having a less amplitude and smaller slope than the alternating current inductance curves of Plate 8, since it is derived from the direct current inductance curves of Plate 3.

The construction indicates a method that can be employed with success in determining, before the machines are built, the wave forms that will be developed by alternators. It is possible to predetermine the fundamental electromotive force and inductance waves of an alternator, by the application of modern methods of design, and from these the load curves and armature reactions can be ascertained by processes analogous to those shown here.

* Steinmetz, "On the Law of Hysteresis." Transactions, vol. xi., p. 574. In this article the author calls attention to the solution of a problem that is analogous to this one, differing from it only to the extent that he works from an assumed sinusoidal inductance-electromotive force and a circuit of negligible resistance.

† Dr. W. E. Sumpner, "Philosophical Magazine," June, 1887, p. 470.

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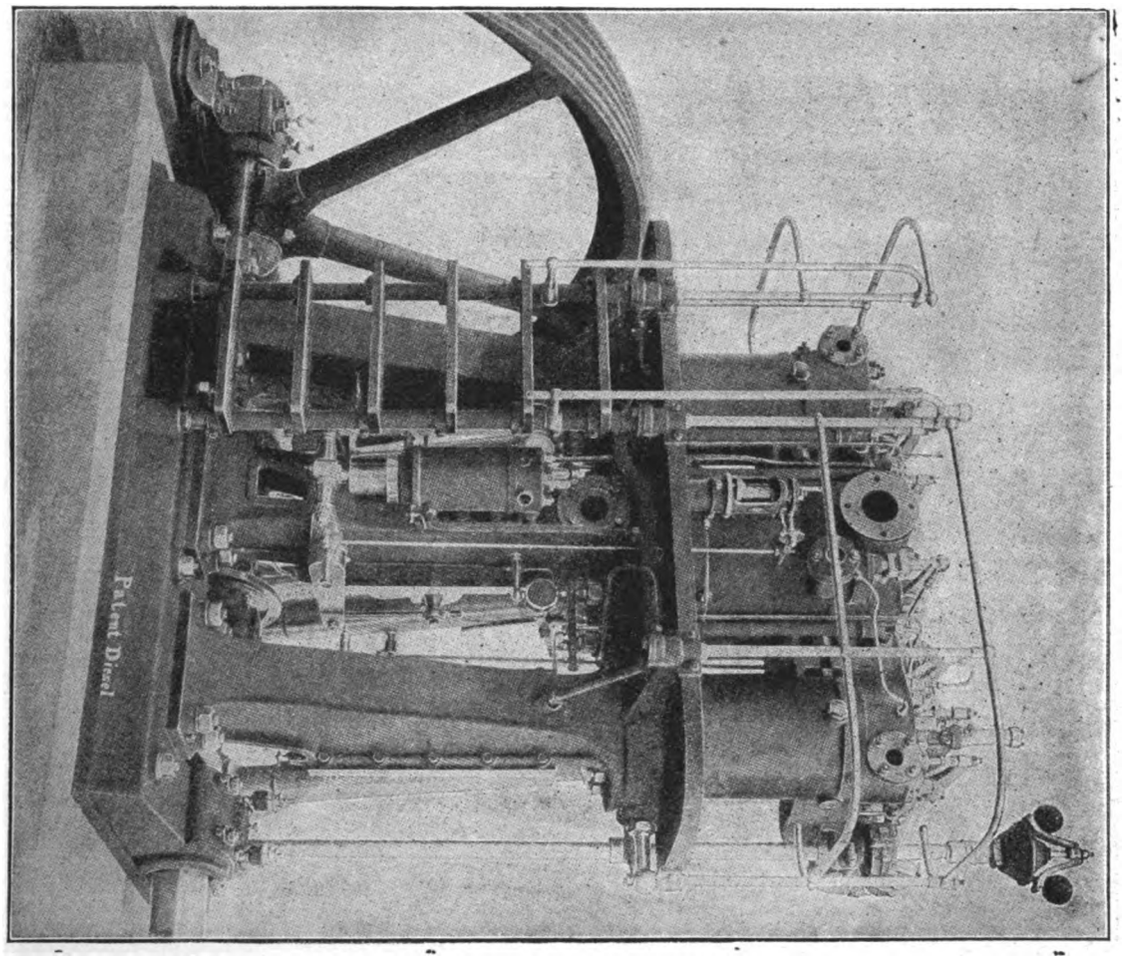
If in the present case it had been desired to calculate the actual current curve with great exactness, an extension of the method used could have been employed. This elaboration necessitates taking the inductance values from Plates 4 and 5, as each point on the current curve is fixed. The process represents a refinement, however, that is hardly warranted in view of the good approximations resulting from the use of the less tedious plan.

(To be continued.)

THE DIESEL MOTOR.

The low efficiency of heat engines has discouraged a great many inventors and prevented them from any further endeavor to improve or otherwise modify their present construction. High-class steam-engines of the very finest mechanical design never exceed eight per cent. efficiency, and the most marvellously constructed triple or quadruple expansion eagines, part of whose equipment consists of a condenser and steam-saving cut-off, does not exceed fourteen per cent. in its efficiency, and so on in other cases where heat is used as a means of obtaining mechanical motion, the losses are greater and greater, increasing rapidly unless the utmost precautions are taken by the exercise of great mechanical ingenuity to prevent them. Then again, in addition to the fuel which passes away in the form of heat, is the smoke nuisance, which in certain large cities will not be endured by the municipality. The inventor of the Diesel motor, in order to avoid the above losses and difficulties, followed this plan. "Pure air is compressed in the cylinder of the motor, thus generating a temperature of about six hundred degrees, centigrade. The fuel to be used, such as gas, petroleum or powdered coal, is thereafter injected into the compressed air, where it is gradually burned up at a much lower temperature than ever before accomplished. During combustion and during the succeeding expansion it is entirely turned into work. The injection and combustion of the fuel takes place as the piston in the cylinder begins its return stroke. It ceases when it has reached about one-eighth or one-sixteenth of its way back, and it is so regulated that the increase in the temperature created by the compression of the air and subsequent combustion of the fuel is reduced by the cooling off due to the work done during the succeeding expansion; thus practically there is no increase in sensible heat, since the heat caused by the combustion of the fuel is immediately turned into power and the motive power thus gained is only reduced by the small amount required for the compression of the air."

Tests have been made of the Diesel motor covering a period of nine months, the result showing that it can turn about twenty-six per cent. of the heat units latent in the fuel into mechanical energy. Comparing these figures with those obtained from a test of either gas or steam-engines, we find a great deal in favor of the Diesel motor. The high efficiency is certainly one of its most remarkable features. But this would be of little or no consequence if it were obtained by sacrificing simplicity of construction or low cost.



Three Cylinder 150 Horse-Power Diesel Motor. Rear View.

The Diesel motor is easier to build and less expensive than the ordinary type of either gas or oil engine. The supply of fuel is regulated automatically and the variations in load are taken up with such ease as to prevent any changes in speed of a perceptible nature.

Another advantage of the Diesel motor is due to its readiness in starting when required for use. There is no time lost in this operation, its smooth running making it far superior to the majority of types using other sources of power already on the market. The fuel used in the Diesel motor is petroleum, although other combustible gases will serve the purpose as well. The machines so far have been manufactured in Nuremberg, many of which

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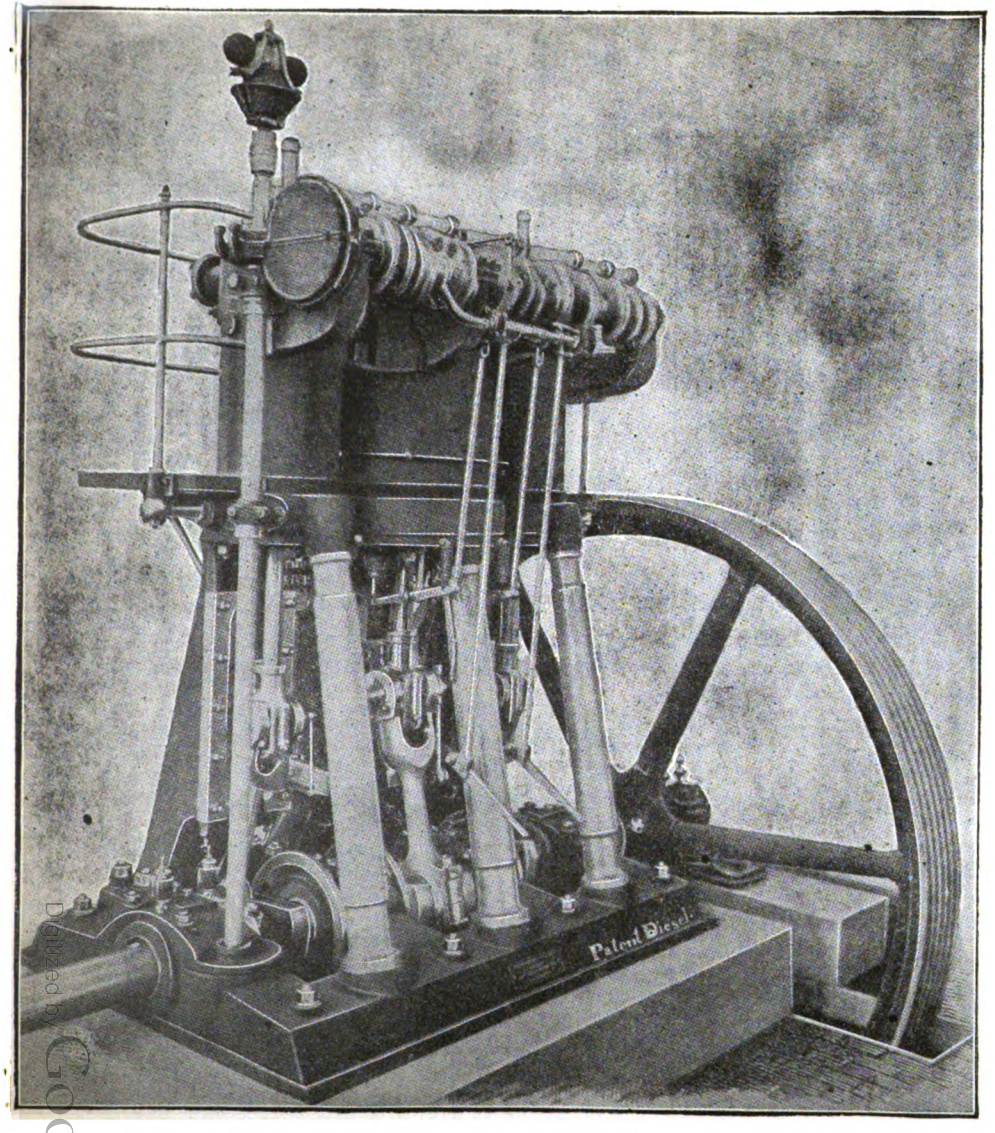
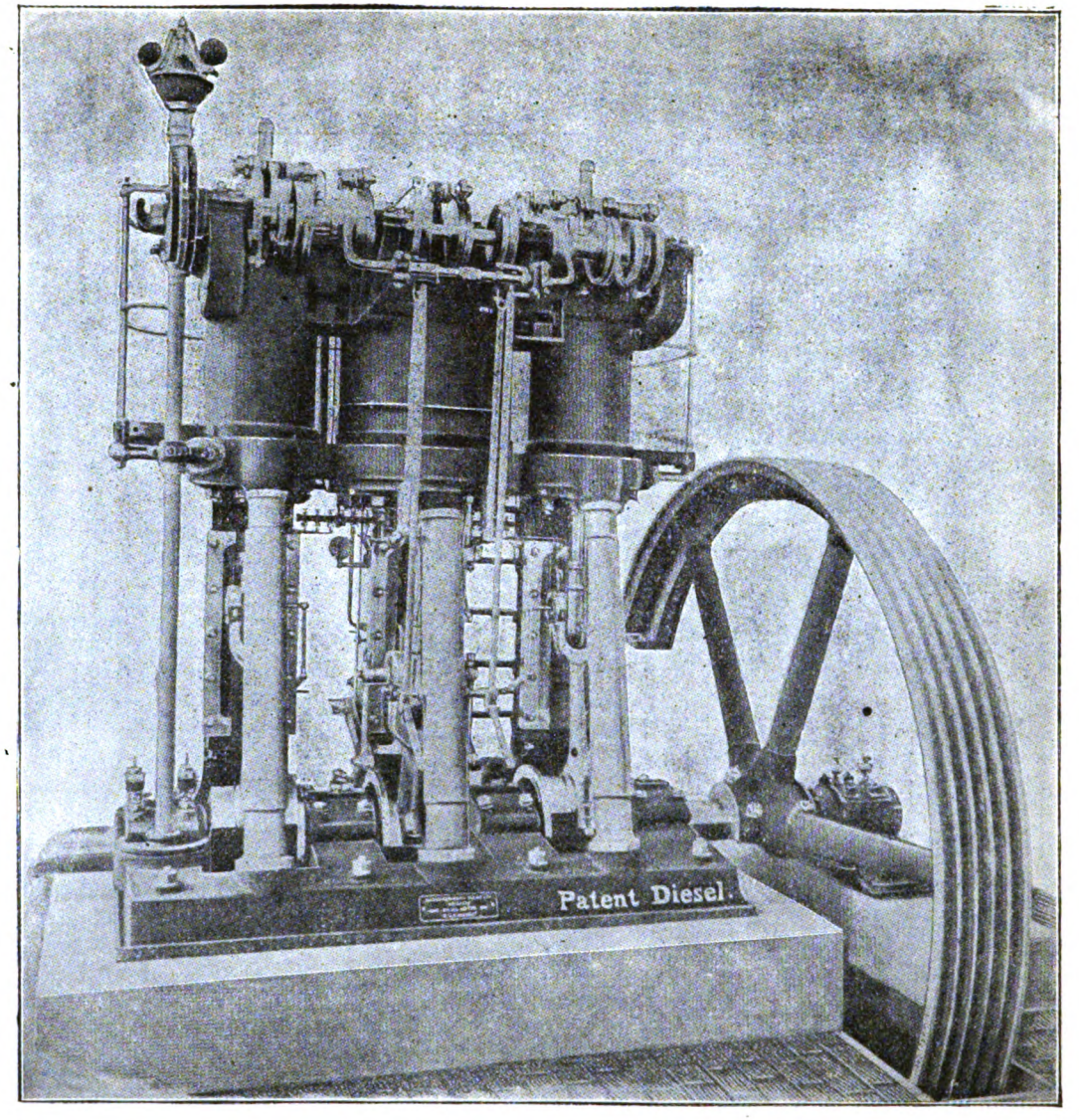


Three Cylinder 150 Horse-Power Diesel Motor in Prospective.



Three Cylinder 150 Horse-Power Diesel Motor. Front View.

DIESEL MOTORS FOR HEAVY POWER.

are in use for railroad work and street cars.

The large firm of Mirrlees, Watson & Yarvan, well-known engineers and builders of heavy machinery, are constructing special reversible Diesel motors to be used for heavy work. Well-known scientific authorities have commended the Diesel motor to the general public on account of its remarkable efficiency, cheapness of construction and excellence of workmanship.

The Diesel Motor Company of America, controlling the patents in the United States and Canada, have offices at No. 11 Broadway, New York City.

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FUEL CONSUMPTION IN ELECTRIC LIGHT PLANTS.

The incandescent lamp, with all its improvements, is still far from being the perfect lamp we expect it to be in the future. Having passed through innumerable experiments which affected its shape, life and brilliancy, it has emerged from all in possession of certain qualities which, specifically stated, refer to its hours of life, power consumption per candle and mechanical durability. In the engine room, away from all the brilliancy of illumination produced by the consumption of fuel, the control of two of these elements, the life and candle power, is in the hands of the engineer. In plants built according to the latest principles in science, and equipped with every means for using fuel in the most economical manner, about three pounds of coal per indicated horse-power hour is thought to be a fair average. A horse-power hour will produce, through the medium of the dynamo and the use of incandescent lamps, from one hundred and sixty to one hundred and eighty candle power. There are many occasions in practice where the engineer, taking the utmost care of the plant in his charge, and controlling the fuel consumption so as to run his engine most economically, does not obtain the equivalent of the horse power in light. In a case like this, the engineer who runs his plant efficiently and is of an economical turn of mind, has also attempted to save his lamps and make them useful for as long a period as possible.

Thus the modern engineer has three things in view, namely: coal to save, a plant to keep in good running order, and lamps to save. It now becomes a question at the end of the year as to whether the engineer has actually been economical to such an extent as to have really saved money for the proprietor of the plant; whether it be private or one used for public illumination. Observation will show that the light has been too well paid for under such circumstances as these, although the engineer in charge will be able to show an economy in fuel consumption and a minimum of burnt-out lamps. Take the case of an electric light plant burning one hundred lamps, requiring ten horse-power, and a coal consumption of one quarter of a ton per day; the plant running ten hours. At $3.00 a ton a run of thirty days would require a little over seven tons of coal, costing about $21.00.

Suppose the engineer, desiring to prolong the life of his lamps over as long a period as possible, runs them a few volts below their proper pressure. He is thereby diminishing the light given out by the lamps from ten to twenty per cent.; the lamp being very sensitive to slight changes of voltage when burning at about twelve candle power, a few volts being sufficient to send it up to sixteen and a slightly increased pressure to a state of blinding incandescence. The small change in volts has but little effect upon the pounds of coal consumed in the engine room, but it will have a remarkable influence upon the light of the lamp. It becomes evident, therefore, that in a well-equipped engine room, under the supervision of a careful man, a loss of from ten to twenty per cent. of the light may be sustained in the desire to prolong the life of the lamps.

One hundred lamps can be replaced at a cost of twenty dollars. If the hundred lamps be kept in service for one year instead of being renewed at the end of six months, the engineer has saved twenty dollars on lamps, but he has wasted about twenty per cent. of the fuel burnt by not allowing these lamps, for lack of normal pressure, from producing sixteen candle power apiece. He has, therefore, burnt twenty per cent. of the fuel unnecessarily; that is to say, wasted $50.40 in an effort to save $20.00 worth of lamps.

These facts, when shown in proper relation to each other, will engage the attention of a practical engineer long enough to make him realize that a saving in lamps is a most expensive piece of business and is only done by sacrificing an item more costly than the object sought. A private installation in charge of an over-careful engineer is frequently run with lamps below candle power. Light produced in this manner is the most expensive we know of, being much dearer than any form of illumination to which reference could be made. The true way to economize is to burn the lamps at their normal pressure and renew them when required. The coal, heat and brightness of the carbon are so closely related that the efficiency of a plant can almost be estimated by considering the two in the manner spoken of above. The general conclusion of any sensible man will be that "You can't cheat the devil in the dark," when running an electric-light plant.

AN ELECTRIC SHRIEKER.

Many of our contemporaries whose journals are not devoted to the interests of electrical engineering offer suggestions which are at times of great value. We desire to anticipate them in speaking of a locomotive whistle, which we think will meet with great applause. This whistle is to be dependent upon hysteretic action in iron. An axle of the locomotive will drive a small high-frequency alternator, from which wires will lead to a coil surrounding sheets of laminated iron. The delightful crescendo due to hysteresis will be an interesting feature of this novel device. The engineer by pressing a button can operate this electric signal at his pleasure. No patents have been taken out on this piece of apparatus to date, but later, when the value of this idea becomes more evident, we may examine patent records—possibly too late.

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N. E. L. A. CONTENTION EXHIBITS AND ATTENDANCE.

(Concluded.)

The New York & Ohio Company, of Warren, O., were represented by W. D. Packard, one of the smartest boys in the lamp trade.

Anchor Electric Company was represented by Manager Marshall and Western Manager Baker.

In dynamos and motors, Roth Bros. & Company, of Chicago, attracted considerable attention.

The Chicago Insulated Wire Company was represented by General Manager Smith, with his pockets full of samples.

Jonesboro Insulated Wire and R. E. Lucas, the secretary of the Indiana Rubber & Insulated Wire Company, were well illustrated at the convention. Paranite, Mr. Lucas wishes you to understand, is his favorite brand.

Mr. W. R. Garton, our old friend of the Garton-Daniels Electric Company, was on hand and kept busy answering questions about their famous lightning arresters.

The Jandus Electric Company, of Cleveland, O., makers of the oldest enclosed arc lamp, were represented by J. H. Cook, Chicago, and H. T. Edgar, New England agent.

President A. M. Searles, of the Diamond Electric Company, and Electrical Engineeer G. A. Scheefer exhibited their most excellent Scheefer meters.

The Central Electric Company, of Chicago, was well represented by its many representatives. We did not get one of those handsome souvenir ash trays distributed by the company.

The Electric Storage Battery Company did not have an exhibit at the hotel. They dispensed hospitality in their parlor. The Edison station contained the greatest exhibit of storage batteries in the world.

Manager R. H. Bouslog, of the Peru Electric Manufacturing Company, Peru, Ind., was on hand with a big line of specialities and their new fuse plug.

The Western Electric Company held a continuous reception in one of the large club rooms of the hotel. The room was made brilliant with their "Sunbeam" incandescent lamps and "Midget" arc lamps. Literature was very plentiful. The hotel was well supplied with Western Electric fans.

The General Electric Company was represented by its entire Chicago selling staff.

Mr. Cyrus O. Baker, Jr., master of transportation, was elected an honorary member of the National Electric Light Association at the Chicago Convention.

Mr. S. Marsh Young, vice-president and general manager of the Manhattan General Construction Co., 11 Broadway, New York, was at the Auditorium Hotel during the convention of the National Light Association with a full line of the new Manhattan Enclosed Arc Lamps. These lamps are designed to burn in multiple on circuits of from 90 to 250 volts, and two or more in series on circuits of from 200 to 600 volts, and on alternating-current circuits of from 90 to 130 volts and any number of alternations. He made a big hit. Mr. Young was the first to place the enclosed arc lamp on the market.

Habirshaw, Dr. William, India Rubber and Gutta Percha Insulation Co., New York; Hagar, Edward M., Southwark Foundry and Machine Co., Chicago; Hanley, W. J., General Electric Company, Cincinnati, O.; Hapeman, Douglas, Thomas Electric Light and Power Company, Ottawa, Ill.; Harrington, Walter E., and wife, Camden and Suburban Railway Company, Camden, N. J; Harris, B. F., Jr., Urbana and Champaign Railway, Gas and Electric Co., Champaign, Ill.; Hart, F. D., Jr., Pineville Electric Light Company, Pineville, Ky.; Hays, W. P., General Electric Company, Cincinnati, O.; Healy, Frank E., Illinois Electric Company, Chicago; Hine, William S., Stanley Electric Manufacturing Company, Chicago; Hirota, Seuchi, Takata & Co., Tokyo, Japan; Hixson, H. R. Simplex Electrical Company, Chicago; Holcomb, Eugene, Holcomb & Green Electric Company, Springfield, Ill.; Hold, W. F., Chicago General Fixture Company, Chicago; Holl, Thomas, Smith-Hill Elevator Company, Quincy, Ill.; Hubbard, W. M., Bradford Belting Co., Cincinnati, O.; Hubley, G. Wilbur, Louisville Electric Light Company, Louisville, Ky.; Hughes, W. D., Central Manufacturing Company, Chattanooga, Tenn.; Hull, J. W., Cabinet Manufacturing Company, Steubenville, O.; Hunt, Charles B., London Electric Company, London, Ont; Huntley, C. R., Buffalo General Electric Company, Buffalo; Hutchins, A. W., D. & W. Fuse Company, Providence, R. I.

Insull, Martin J., C. & C. Electric Co., Chicago; Insull, Samuel, Chicago Edison Company, Chicago.

Jackson, George T., National Conduit and Cable Company, New York; Jackson, D. C., professor in the University of Wisconsin, Madison, Wis.; Jenney, Charles D., Jenney Electric Manufacturing Company, Indianapolis; Jennings, John J, Wilkinsburg Electric Company, Wilkinsburg, Pa.; Johannson, J. E., Wagner Electric Manufacturing Company, St. Louis; Johns, S. C. D., and wife, Cleveland Electric Illuminating Company, Cleveland, O.; Johnsson, Edward H., Sprague Electric Company, New York.

Keck, T. P., Brush Electric Light Company, Savannah, Ga.; Kelsh, R. S, Lachine Rapids Hydraulic and Land Company, Montreal, Canada; Kimball, Frederick M., General Electric Company, Boston; Kimbrough, Hal. C., Muncie Electric Light Company, Muncie, Ill; Kingan, W. F., Edison Sault Electric Company, Sault Ste. Marie, Mich.; Kittle, E. B., Sprague Electric Company, Chicago; Knox, G. W., Chicago City Railway Company, Chicago; Kohler, G. A. Edward, Kohler Bros., Chicago; Korst, P. H., Badger Electric Company, Racine, Wis.; Kreidler, W. A., Western Electrician, Chicago.

Lang, A. E., Toledo Consolidated Electric Company, Toledo, O.; Layman, W. A., Wagner Electric Manufacturing Company, St. Louis; Leslie, E. A., Manhattan Electric Light Company, New York; Livsey, J. H., General Electric Company, Detroit, Mich.; Lloyd, Herbert, Electric Storage Battery Company, Philadelphia; Lockwood, Joseph D., Michigan Electric Company, Detroit, Mich.; Lowell, James G., Bay County Electric Company, Bay City, Mich.; Lucas, R. E., Indiana Rubber and Insulated Wire Company, Marion, Ind.; Lukes, J. B., United States Electric Lighting Company, Washington, D. C.; Luthy, G. G., Royal Electric Company, Peoria, Ill.

Manson, George T., Okonite Company, New York; Marsh, Converse D., Bryan Marsh Company, New York; Marshall, Norman, Anchor Electric Company, Boston; Matlock, E. V., Laclede Power Company, St. Louis; Matthews, W. N., St. Louis Electrical Supply Company, St. Louis; McDonald, W. B., Commonwealth Electric Company, Chicago; McGhie, J., General Electric Company, New York; McGill, T. Julian, Westinghouse Electric and Manufacturing Company, Chicago; McGraw, J. H., "American Electrician," New York; McKinlock, George A., Central Electric Company, Chicago; McKinlock, W. H., Chicago; McQuaide, James P., National Conduit and Cable Company, New York; Mercein, Thomas R., secretary Northwestern Electrical Association, Milwaukee, Wis.; Messer, Charles, Dearborn Electric Company, Chicago; Miller, J. H., Springfield Electric Light and Power Company, Springfield, O.; Miller, A. M., Red Oak Electric Company, Red Oak, Ia.; Mitchell, O., Muncie, Ind.; Mold, William S., Star Electric Company, Dubuque, Ia; Morrell, A. W., Miller-Knoblock Company, South Bend, Ind.; Morrill, J. B., Evanston Electric Illuminating Company, Evanston, Ill.; Morse, S. F. B., Chicago; Morse, A. M., Atlas-Corliss Company, Chicago; Mustard, John, Wagner Electric Manufacturing Company, Philadelphia.

Neal, George B., Charlestown Gas and Electric Company, Boston; Nelson, Frederick, Westinghouse Electric and Manufacturing Company, Chicago.

O'Connor, Richard, National Carbon Company, Cleveland.

Packard, W. D., New York and Ohio Company, Warren,

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O.; Page, A. D., General Electric Company, Newark, N. J.; Paige, C. C., Electric Light and Power Company, Oshkosh, Wis.; Perkins, C. G., Perkins Switch Manufacturing Company, Hartford, Conn.; Perry, C. C., Indianapolis Light and Power Company, Indianapolis, Ind.; Phillips, Frank N., American Electrical Works, Providence; Porter, George F., Kerite Wires and Cables, New York; Pratt, Frederick S., Cumberland Electric Light and Power Company, Nashville, Tenn.; Prentiss, I. R., General Electric Company, Philadelphia; Price, Charles R., New Bedford Gas and Edison Electric Light Company, New Bedford, Mass.; Price, Charles W., "Electrical Review," New York; Pritchard, W. R., Westinghouse Company, Chicago; Pumpelly, J. K., Chicago; Pyle, James E., Edison Electric Illuminating Company, West Chester, Pa.

Rae, F. B., Chicago; Randolph, R. J., Sterling Arc Lamp Company, New York; Ray, William D., Johnson Company, Chicago; Reber, James C., Dayton Electric Light Company, Dayton, O.; Redman, George A, and wife, Brush Electric Light Company, Rochester, N. Y.; Reeves, J. W., Johnstown Electric Light Company, Johnstown, Pa.; Rex, George P., Columbia Incandescent Lamp Company, Chicago; Rice, C. W., Kings County Electric Light and Power Company, Brooklyn, N. Y.; Robertson, A. M., Minneapolis General Electric Company, Minneapolis, Minn.; Robinson, D. P., Edison Electric Illuminating Company, Baltimore, Md.; Rockwood, G. O., Rockwood Manufacturing Company, Indianapolis, Ind.; Roehl, Charles E., St. Joseph Railway, Light, Heat and Power Company, St. Joseph, Mo.; Rogers, L. H., Fort Wayne Lamp Company, Cleveland, O.; Rose, E. M., Farmington Electric Light Company, Farmington, Ill.; Rosenthal, George D, General Electric Company, St. Louis; Ross, C. A., Sawyer-Man Electric Company, Chicago.

Schayer, John J., Commonwealth Electric Company, Chicago; Scheeffer, G. A., Diamond Electric Company, Peoria, Ill.; Searles, A. M., Diamond Electric Company, Chicago; Shain, Charles D., Weston Electrical Instrument Company, New York; Shainwald, J. C., Standard Paint Company, Chicago; Shaw, A. C., "Electrical Engineer," New York; Shay, J. H., Charles Munson Belting Company, Chicago; Smith, C. R., Manhattan Light, Heat and Power Company, St. Paul, Minn.; Smith, F. E., Lynn and Boston Street Railroad Company, Boston; Smith, H. S., Sawyer-Man Electric Company, Pittsburg; Smith, T. Ellwood, Somerville Electric Light Company, Boston; Smith, William M., Chicago Insulated Wire Company, Chicago; Smith, W. S, Toledo Consolidated Electric Company, Toledo, O.; Stacey, Thomas I., Electric Appliance Company, Chicago; Stearnes, R. S., Fort Wayne Electric Corporation, New Orleans, La.; Stern, M. L., City Electrician, Denver, Colo.; Stetson, George R., New Bedford Gas and Edison Light Company, New Bedford, Mass.; Stieringer, Luther, New York; Sunny, B. E, General Electric Company, Chicago; Svenson, John, Bullock Manufacturing Company, Chicago.

Thayer, George L., Belle Plaine Electric Light Company, Belle Plaine, Ia.; Thorne, J. J., Electric Engineering Company, Bay City, Mich.; Tompkins, W. H., City Electric Lighting Plant, Niles, Mich.; Torbert, H. G., Dubuque Light and Traction Company, Dubuque, Ia.; Trego, Charles H., Hoopeston Electric Company, Hoopeston, Ill.; Trump, Samuel N., Wilmington City Electric Company, Wilmington, Del.

Uptegraff, J. W., Sewickley Electric Company, Sewickley, Pa.; Urquhart, D. F., T.-H. Carbon Company, Boston.

Van Trump, C. R., Wilmington City Electric Company, Wilmington, Del; Varney, G. E., Varney & McOuat; Indianapolis.

Wade, E. E., El Paso Electric Company, Colorado Springs, Col; Wagner, Herbert A., Missouri-Edison Electric Company, St. Louis; Walbank, W. McLea, Lachine Rapids Hydraulic and Land Company, Montreal, Canada; Watriss, A. W., Charles A. Schieren & Co, Chicago; Webb, A. F., American Carbon Company, Noblesville, Ind.; Webb, H. E., Solar Carbon and Manufacturing Company, Pittsburg, Pa.; Weeks, Edwin R., Kansas City Electric Light Company, Kansas City, Mo.; Wells, H. S., Smith-Hill Elevator Company, St. Louis; Wells, R. S., Shelbyville Water and Light Company, Shelbyville, Ill.; Wells, Edward F., Shelbyville Water and Light Company, Shelbyville, Ill.; Wendle, G. E., Lycoming Electric Company, Williamsport, Pa.; Wetzler, Joseph, and wife, Electrical Engineer, New York; Whyte, George S., Leschen-Macomber-Whyte Company, Chicago; Wiley, J. R., Standard Underground Cable Company, Chicago; Wilkins, E. Ward, Partrick, Carter & Wilkins, Philadelphia; Wilkinson, C. D., Western Electric Company, Chicago; Williams, John R., Electric Storage Battery Company, Philadelphia; Wilmerding, C. H., Chicago Sectional Underground Electric Company, Chicago; Wilson, Charles E., Fort Wayne Electric Corporation, Philadelphia; Wolff, James, New York Insulated Wire Company, Chicago; Woodbridge, J. E., Electrical World, New York; Wright, Peter, Virginia Electric Company, Norfolk, Va.; Wunder, F. A., Fort Wayne Electric Corporation, New York; Wurts, Alexander J., Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. Wyant, Robert E., Derby Gas Company, Derby, Conn.

Young, E. P., Sewickley, Pa.; Young, S. Marsh, Manhattan General Construction Company, New York.

Zamel, A. G., Zamel Arc-Light Meter Company, Chicago.

JOSEPH HENRY BURKE.

We are pleased to make mention of the excellent work being done by Mr. Joseph H. Burke, formerly an inspector of the Board of Electrical Control of New York City, now occupying a position of considerable prominence in Queens Borough, L. I. The Brooklyn Eagle comments as follows upon his able services:

"The public buildings now cared for by the department are the town halls at Jamaica, Newtown and Flushing; village halls at Whitestone, Richmond Hill; the borough hall at Long Island City and justices' court rooms at Far Rockaway, Flushing and Long Island City.

The same department has charge of every electric light, telegraph, telephone and trolley wire in the borough. The whole district has been mapped out and every line of wire marked out upon charts in the possession of the department, so that in any application for extensions or changes the location can be determined at a glance. Not a pole can be erected or a line of wire strung without a permit from the department. This is in marked contrast to the methods that prevailed before the local governments were merged into those of the city. Chief Inspector Joseph H. Burke and his corps of assistants are constantly travelling about the borough looking after the thousands of miles of wires and thousands of poles, and in seeing that all work is done in strict compliance with the regulations of the department and that no work is done without a necessary permit from the department.

The principal companies in the borough under the charge of this office are the Long Island Electric Railroad, New York and Queens County Railroad, Brooklyn Heights Railroad, Newtown Light and Power Company, Citizens' Illuminating Company of Long Island City, New York and Queens Light and Power Company, Jamaica Electric Light Company, Citizens' Light Company of Far Rockaway, Bowery Bay Electric Light and Power Company, Electric Illuminating and Power Company of Long Island City, New York and New Jersey Telephone Company, Western Union and Postal Telegraph companies, and several gas and naphtha illuminating companies. The department looks after the safety of the entire community as to life and property in the matter of electric wires.

The great area of the borough of Queens, comprising over 123 square miles, about as much territory as the three boroughs of Brooklyn, Manhattan and the Bronx combined, makes the labor of inspection a great one, and the duties of the borough office are constantly growing."

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ADDRESS OF SAMUEL INSULL.

Pres. of Chicago Edison Co.

(Conclusion.)

Selling Price Based on Cost.

It is of prime importance to central station managers that they should sell the product they manufacture, namely, electric current, to the greatest number of customers at the lowest possible price, and yet obtain a reasonable profit. For a number of years the basis of charge on the part of most companies has been a given unit price, with discounts for quantity. In the early days of the business some companies were in the habit of charging a fixed price per lamp per month, having no control whatever over the use of the product, but being necessarily responsible for the increased operating expenses caused by the wastefulness of customers, who could hardly be expected to economize, inasmuch as they paid exactly the same price for the use of light, whether they burned it one or twenty-four hours a day. A majority of these companies, however, following this last method, realized at an early date the absurdity of distributing that for which they were not paid, and as a result I presume we can fairly assume that electric lighting business (with the exception of arc light service) is run almost universally on a meter basis. It is therefore unnecessary for us to discuss the question as to whether the measuring of current is a desirable thing in our business, as it is now generally recognized as a necessity. If you will make a careful examination of the factors entering into the cost of current you will very quickly come to a realization of the fact that interest is by far the most important single element, and that this item varies very considerably with the different classes of service furnished by a central station company. The interest factor in cost depends upon the yearly average consumption of your product by the customer; or, to put it another way, you can figure your interest on the basis of so much per unit of output at maximum load. For instance, take the two probably extreme classes of customers to whom the central station company supplies current for lighting purposes. On the one hand, you have an office building whose tenants only use artificial illumination for a very short space of time each day during the winter only. On the other hand, you have a basement customer whose use of your product averages nearly one-half of the day of twenty-four hours during the whole year. Your investment, to take care of each of these customers, is practically the same; therefore your total interest cost must be the same in both cases, but if you distribute this interest cost over the actual units consumed you will find that the tenant of the office building costs you for interest per unit of current sold many times more than the occupant of the basement. There are of necessity as many different grades of customers between the two extremes I have mentioned as there are different classes of business and different characters of structnres in which these businesses are conducted. Surely, if the cost of production varies according to the different conditions under which your customers use your product, it is but fair that the selling price per unit should vary correspondingly. If it does not, you, of necessity, encourage the use of electricity by customers whose business is unprofitable to you, and discourage the use of your product by customers whose business at a lower price would yield you a fair return.

In past conventions the question of how to improve the day load for the purpose of raising the average output, what classes of business should be encouraged other than lighting to achieve this result, and the price at which we can afford to sell current to the operators of these different lines of business, have come up for discussion. At the last convention the realization of the fact that great differences exist in the elements governing the cost of product for different classes of lighting customers was ably presented by Mr. Arthur Wright, and he pointed out that the improvement of your load factor, the broadening of your curve and the rendering less acute of your peak is a matter within your own adjustment, providing that you will realize in considering cost with a view to making a selling price that conditions are so dissimilar that the expense to you per unit of supplying two customers in the same block is likely to be widely different. Various plans have been adopted by a comparatively small number of companies to meet the conditions as we now know them to exist. Some companies have adopted the scheme of allowing certain special discounts, providing the income per month per lamp connected exceeds a certain amount. Other companies charge one rate for current used during certain specified hours of the day and a much lower rate for the current used during the remaining hours of the day. A third method is a system of discounts based upon the total consumption of current during a given period, considered in connection with the maximum consumption at any time during that same period.

These various methods all have the same object in view, namely, the meeting of the conditions of each individual customer, and yet at the same time earning a fair return on all of the investment provided for all of your customers.

Samuel Insull, Ex-Pres. N. E. L. A.

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In discussing this matter I have referred alone to interest cost because it forms so large a proportion of the total cost, but you will find that this same principle enters into a number of the other elements which go to make up your total cost. It would therefore appear to me that in considering the cost of generating electricity you should bear in mind that a large proportion of the items which go to make up the total are within your own control, and their amount per unit of output depends very largely upon the methods adopted in selling your product.

Public Control and Private Operation.

A subject of growing importance to a number of our members is the question of the public ownership and operation of the undertakings now operated by electric lighting companies. The agitation in connection with this subject has called forth a great deal of discussion, partly by those interested in it simply with a view to extending the influence of political parties, and partly by serious disinterested thinkers who believe that the best interests of the greatest number are to be obtained by the creation of a municipal socialism, which, if carried to its logical conclusion, must ultimately result in municipalities performing, with others, such public service work as we are engaged in, and also in producing the food we eat and the clothes we wear. To those occupied in the management of electric lighting properties it does not seem possible that the movement in favor of municipal operation of electric lighting plants, based upon the assumption that a municipality can produce electricity cheaper than, or even as cheap as, a private corporation, is well founded. We all realize, from the close attention we have to give to our own affairs, that self-interest and the necessity of getting a return on our investment are the first essentials to the economical administration of large enterprises.

While I do not pretend to claim that electric lighting companies are beyond reproach, I wish to point out that many of the evils complained of as pertaining to corporate management are the direct results of the enforcement of unwise conditions through legislative action. Ill-advised efforts are often made by legislative bodies to secure advantages in the direction of control which cannot be obtained without giving an equivalent in protection to the industry. This causes the investor to feel that his property is being attacked and compels him to resist such legislation. The result is a feverish agitation, crimination and recrimination, between the would-be improvers of municipal government and the owners of corporate properties without reaching a conclusion satisfactory to either. The fallacy of the so-called reformer's theory results from looking only at what he calls the injurious effects of corporate management without taking into account its indisputable benefits. He does not seek for the cause of the trouble. If reformers will take accurate account of all the points in the problem, they will discover that the evils complained of result from errors in legislation designed to determine the relations between municipal bodies and electric lighting companies. It seems to me that the claim that municipal operation is the universal cure for all diseases for which electric lighting companies are supposed to be responsible merely proposes the substitution of political in the place of industrial management. This raises the question: Is the administration of municipal affairs in the various cities throughout this country so economical as compared with the management of private industries and the class of service rendered so efficient as to justify the increasing of the burdens already imposed upon municipal government? It appears to me that a correct division of power and responsibility requires political government to control private industrial management. Where political government and industrial management are merged into one interest, the power of control is seriously impaired, since a political administration cannot be reformed without overturning the party in power.

I cannot bring myself to the belief that the citizens of this great country are in fact opposed to large aggregations of capital in corporate form, as such aggregations are absolutely necessary to the operation of all great undertakings by private enterprise. It is as impossible to operate such vast affairs with individual capital, as a personally owned business, as it is for us to live without municipal, state and national governments. The misunderstandings which from time to time occur between communities and the managers of electric lighting companies will, to my mind, disappear entirely if the relations between the two are correctly founded on the basis of public control, with corresponding protection to the corporations operating this industry. It would seem to me to be a very proper function for this Association to address itself to educating the public to a definite legislative policy which will be fair to the municipalities, securing to the public the best service at the lowest possible price, and protect corporations by giving them franchises, which, while conserving municipal control, will insure to the investor the permanency of the undertaking.

Competition Is Not the True Regulative Force.

It is supposed by many who discuss municipal affairs that the granting of competitive franchises for public service work is the true means of obtaining for users the lowest possible price for the service rendered, whereas, as a matter of fact, the exact opposite is the ultimate result. This is proved by results in all large cities where the most severe competition has taken place. Acute competition necessarily frightens the investor, and compels corporations to pay a very high price for capital. The competing companies invariably come together, and the interest cost on their product (which is by far the most important part of their cost) is rendered abnormally high, partly owing to duplication of investment and partly to the high price paid for money borrowed during the period of competition. The selling price of a service should be based on its cost, and in any business, such as public work, where the investment is large and the annual turn-over is comparatively small, if the item of interest be unnecessarily augmented, it must be reflected in the price paid by public and private users.

While it is not supposed to be popular to speak of exclusive franchises, it should be recognized that the best service at the lowest possible price can only be obtained, certainly in connection with the industry with which we are identified, by exclusive control of a given territory being placed in the hands of one undertaking. In most European countries public service operations enjoy exclusive franchises, under proper control, and are able to obtain capital for their undertakings at the lowest commercial rates, thus materially affecting the cost of their product, of which interest, as I have already stated, is necessarily so great a part. In order to protect the public, exclusive franchises should be coupled with the condition of public control requiring all charges for services fixed by public bodies to be based on cost, plus a reasonable profit. It will be found that this cost will be reduced in direct proportion to the protection afforded the industry. The more certain this protection is made the lower the rate of interest and the lower the total cost of operation will be, and, consequently, the lower the price of the service to public and private users. If the conditions of our particular branch of public service are studied in places where there is a definite control, whether by commission or otherwise, it will be found that the industry is in an extremely healthy condition, and that users and taxpayers are correspondingly well served.

Compensation for Franchises.

When prices for services are based on cost, it matters not whether in the establishment of a system of legisla-

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tive control provision is made for paying a portion of the receipts direct to the municipality. If the public demands a percentage, surely we can afford to pay it, as it would simply be added as an item of expense on which our selling price would be figured. If the public does not demand a percentage, this selling price would be proportionately less. It is simply a question as to whether our municipal bodies prefer to raise a portion of their income by taxing their citizens through the agency of public service corporations, or whether they prefer to raise that portion of their income by collecting it direct from citizens themselves. Revenue raised by a percentage on gross receipts of the electric lighting business would, at the present time, however, seem to be somewhat unfairly obtained in cases where the selling price is subject to legislative control and based on cost of service, as the result would be that a small minority of citizens using electricity would be forced to contribute largely to the public revenue, whereas the benefits enjoyed therefrom would be to the advantage of the whole community.

Taking Private Property for Public Use.

Another point that should be included in a proper scheme of public control is a condition under which the municipality would have the right to purchase the undertaking. Such a right should include a direct obligation on the part of the municipality to purchase the property at a fair price whenever it is thought desirable that the industry should be operated by the municipality. The possibility of the exercise of the right of purchase by the municipality would of itself make it to the interest of the owners of the property to do their full duty in their relations to the public. On the other hand, if a community licenses a corporation to perform a certain public service, and if that corporation invests its money and develops its business, surely it is unfair for that community to go into the same line of public service work itself without first purchasing the existing plant. If this is not done the value of private property will de destroyed without just compensation being made therefor in an attempt to secure a public benefit. I do not believe that the people as a whole are so unfair as to demand that such a course shall be taken.

My recommendations on the subject, which I have just presented, are by no means original. Most public service corporations in Great Britain are run on practically the bases indicated, and in more than one state in the Union corporate legislation has taken the same direction.

I would summarize the position which I think we should take on this subject in just two sentences.

First—Franchises granted to public service corporations should secure them the same degree of protection in their rights to their property as is enjoyed by other investments.

Second—Public control of charge for service based on cost, plus a reasonable profit, and eliminating the factor of competition, is the proper safeguard for the interests of users, taxpayers and investors.

CUTTING SUBMARINE CABLES.—The following paragraph appeared in the London "Electrician" of June 10th, and its publication in your columns cannot fail to be of interest to your readers.

Yours very truly,
James Brown,
Supt.

"With reference to statement made in daily press, that if the United States interrupt telegraph communication with Spanish colonies, Spain will retaliate by severing the cables between the U. S. and Europe, we desire again to point out in the strongest manner the futility of such an attempt, which would only result in injury to neutral property, without effecting the desired object, and would inevitably lead to heavy claims for damages, to say nothing about the practical impossibility of breaking some twelve or thirteen cables before those first severed have been repaired. We have it on the authority of one of the Atlantic companies that they have transmitted readable code words through a cable five hundred miles long, broken about midway, by means of apparatus invented by A. C. Brown, of the Single-Wire Multiple Telephone Signal Co."

THE COST OF OPERATING ELEVATORS BY STEAM, WATER AND ELECTRICITY.

The cost of operating elevators by steam, water and electricity has properly become the subject of careful investigation, in view of the extensive and growing use of these appliances. It is stated that in New York, the home of so many sky-scrapers, a larger number of persons are carried vertically in elevators than are transported horizontally by the various forms of traction. Experience with electric elevators in the United States is said to have shown the cost of carrying a useful load 1500 pounds to a height of 100 feet, inclusive of return to starting-point, to be one cent. In Berlin and Vienna the cost is reported to be considerably below the figure mentioned. In the former city the cost of lifting by electricity a load of 850 pounds to a height of 80 feet, inclusive of descent, was only one-fifth of a cent.—The Canadial Architect.

It will be of interest to the general public, hardly less than to the electrical fraternity, to know that Lieut. Frank J. Sprague, who has for the last six weeks been confined to his house, and in great suffering, from a severe injury to his right eye, is in a fair way to recovery. Nearly two months ago, a piece of the eyeglass Mr. Sprague was wearing was accidentally forced into the ball of the eye, and Mr. Sprague had to remain for some two weeks under the care of a specialist. Being very anxious to push forward to definite shape the Volunteer Corps of Electrical Engineers, which he offered some time ago to organize for early service at the front, Mr. Sprague imprudently went to Washington, where he caught cold in the injured eye. Severe complications set in, along with iritis, and for some time it was feared that blindness was inevitable. This danger, however, seems to have passed, and there is every prospect that Mr. Sprague will soon be able to renew his active part both in the affairs of the company with which he is identified, and the formation of a fighting corps that should fill a place of its own in the war resources of the Government.

Rutland City, Vt.—The Rutland City Electric Co. is removing to its new plant.

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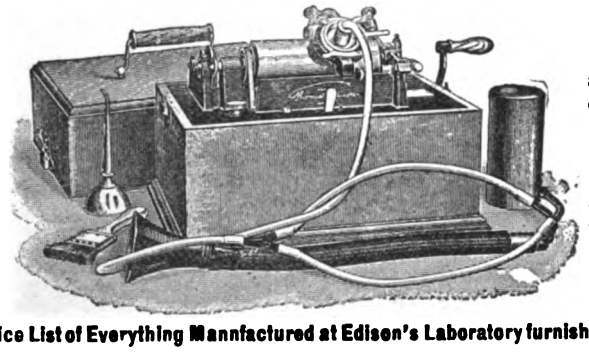

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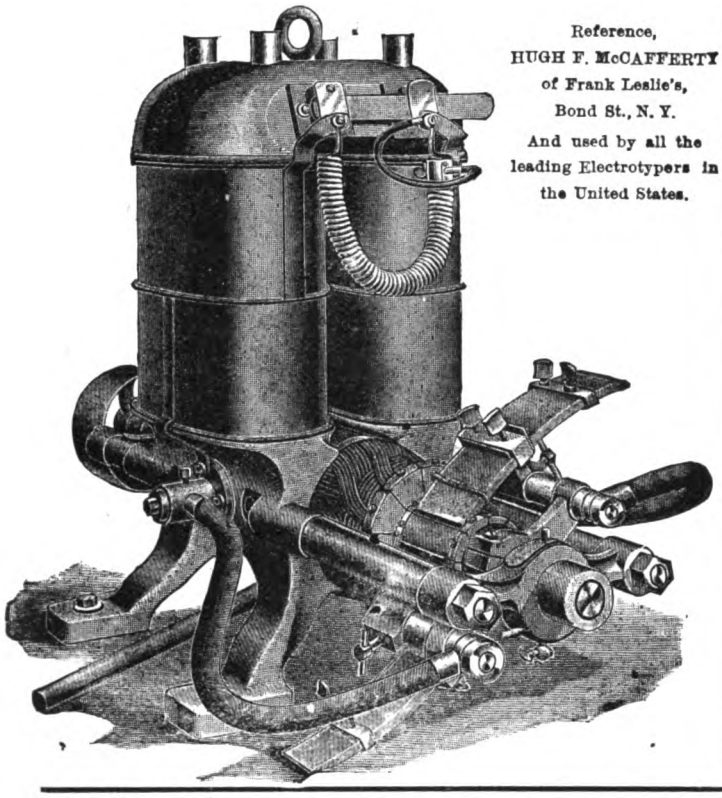

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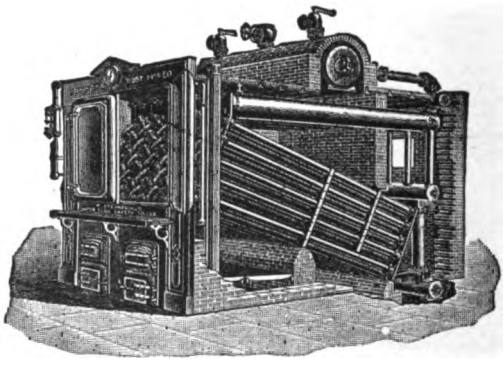

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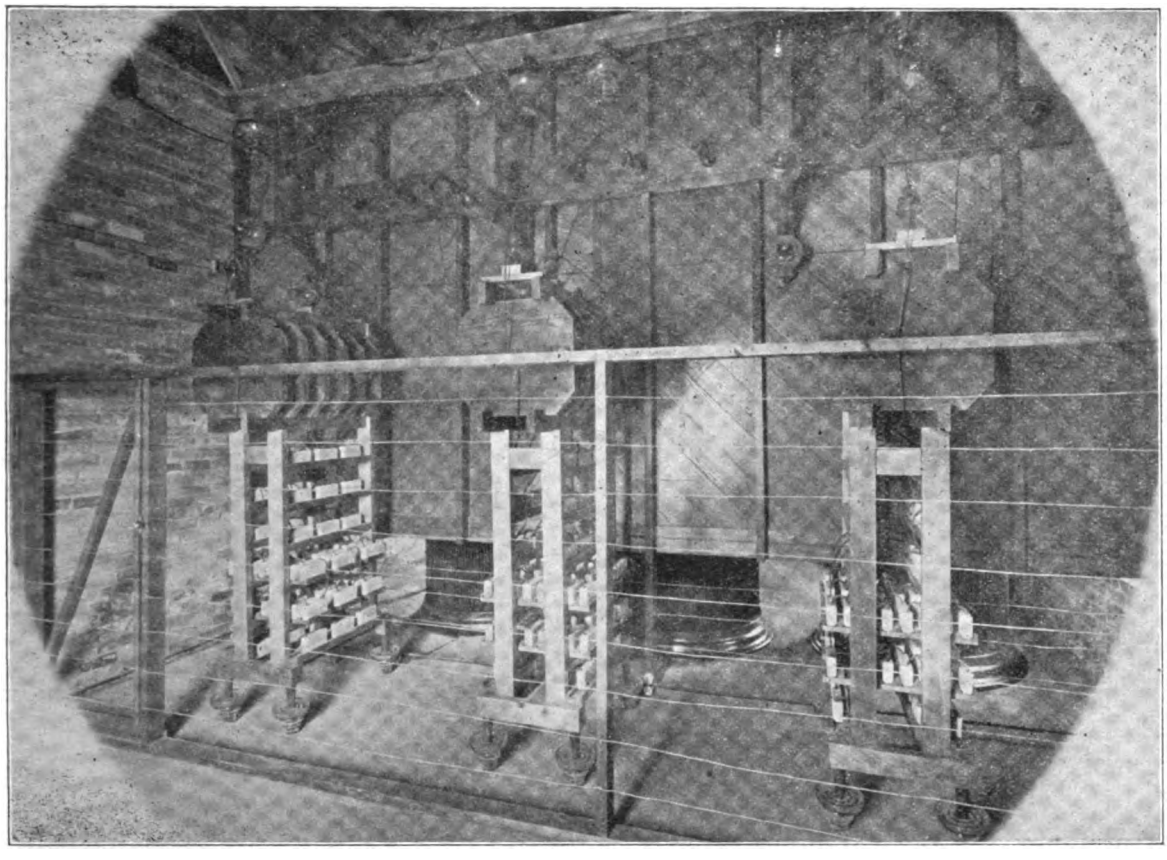
The Electrical Age.

VOL. XXII—No. 1 NEW YORK, JULY 2, 1898 WHOLE NO. 581



Lightning Arresters in High Tension Room, Golden Gate Mill, Utah.

ELECTRIC POWER AT THE GOLDEN GATE MILL, UTAH.

(*Through the courtesy of the Engineering and Mining Journal.*)

The largest cyanide mill in the world, the Golden Gate, at the Mercur mines in Utah, is operated by electric power, which is transmitted from the generating plant, a distance of 35 miles, to Mercur, at a potential of 40,000 volts. The entire outfit is of Westinghouse manufacture, and exemplifies the high development that has been made in the construction of machinery for long-distance power-transmission enterprises. The Telluride Power Transmission Company supplies the power, which is transmitted in three phases to the Golden Gate mill. This is situated at the entrance to the mines, 35 miles southwest of Salt Lake City, at the terminus of the Salt Lake & Mercur Railroad. The town of Mercur is the business centre of the Camp Floyd mining district, and the Golden Gate mill represents the most extensive application of the cyanide process to the ores of that region. The capacity of the plant is over 500 tons of ore per day.

The mill is a steel structure, situated on the side of a steep hill, which was blasted so as to obtain level spaces of sufficient width to provide a foothold for the foundations. Provision has been made for minimizing the labor of conveying, by allowing the ore to start at the top of the hill and proceed by gravity from each level to the next below in the course of the different processes of treatment. The buildings cover 4 acres, being 294 ft. in width along the side of the hill, and 420 ft. in length up and down the slope. The difference in vertical height between the upper and lower ends of the mill is over 400 ft. The buildings are shown in the illustration, Fig. 1, which gives a view of the entire plant. The mines, not shown in this figure, are situated below the part of the slope that appears in the illustration. There are eight levels in the mill proper. The loose stone produced in blasting out these levels was used in building the foundations and retaining walls. These walls are 2 ft. wide at the top, and have a batter of 1 in 12. They comprise over 5,000 cu. yds. of rubble masonry, laid in lime mortar. The structural steel work of the building contains over 2,400,000 lbs. of metal.

The installation of the motors was in charge of the Mountain Electric Company, of Denver, Colo., under the supervision of Messrs. Nunns, the general contractors.

In the transmission of power to Mercur, the loss of electric energy is extremely low, being scarcely 5 per cent. In that dry region, high potential lines require but little attention, and wastes are reduced to a minimum. Current is delivered to the mine at $60 per H. P. per year, with a minimum consumption of 300 H. P. stipulated. The transformer house, which contains the apparatus for converting the current from 40,000 volts, three-phase, to 220 volts, two-phase, is located between the shaft house and the mill. A view of the interior of the high-tension room is given in Fig. 2, which shows the general arrangement of the Wurts lightning arresters and high-tension lines.

The ore is hoisted from the shaft on an incline to the crusher situated at the top of the hill, a distance of 800 ft. This first, or upper, story of the mill is devoted to the coarse crushing of the ore, and is 25 ft. wide by 75

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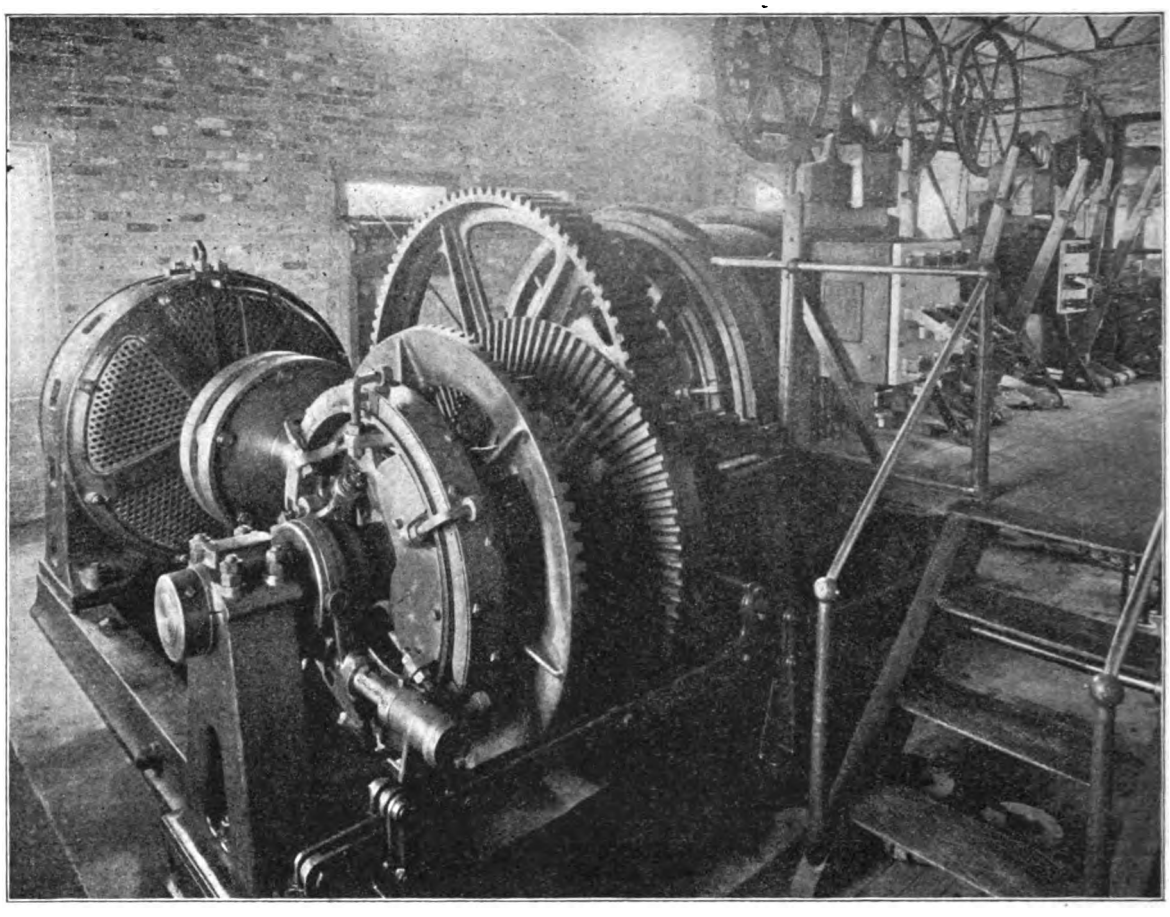
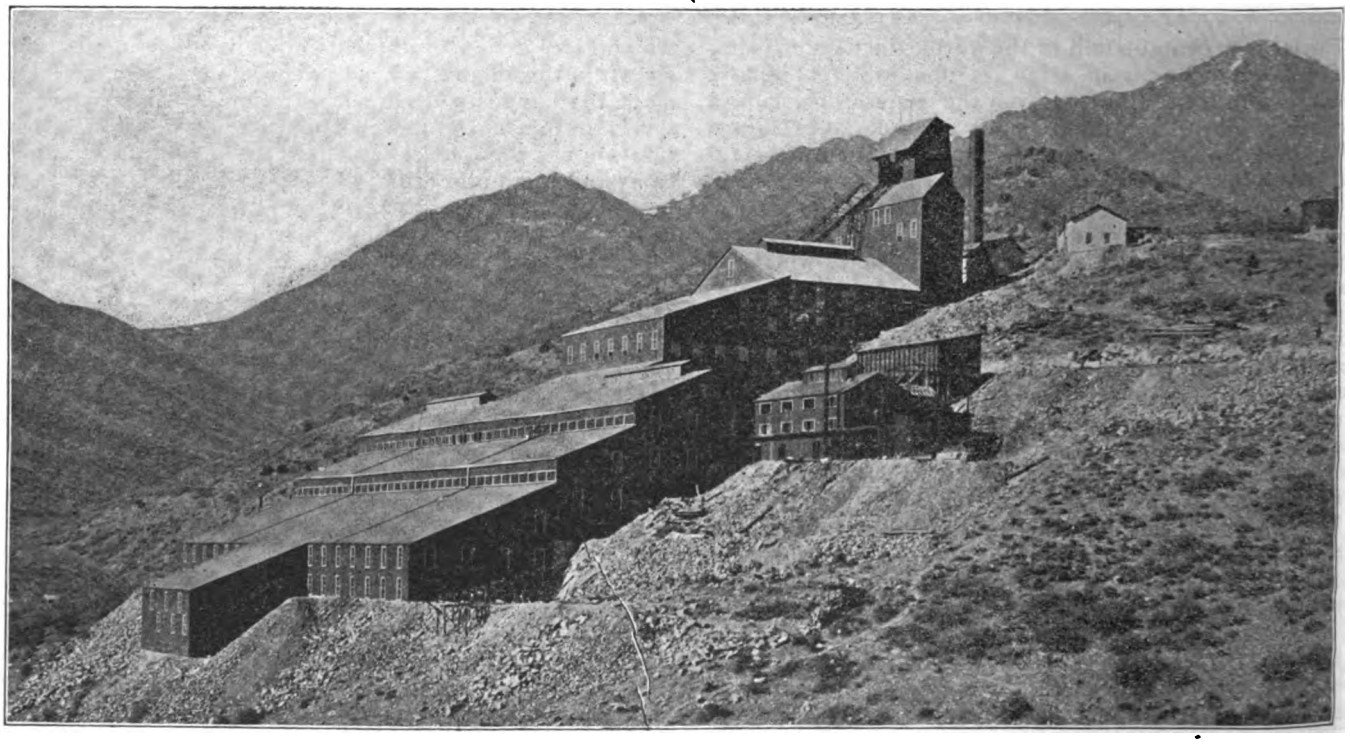
ft. long, the height being 100 ft. It is divided into three floors. The upper floor receives the ore in bins, just as it comes from the shaft. The middle floor contains the crushers, weighing 20 tons each, and having a combined capacity of 1,500 tons daily. They are operated by two 50 H. P. Westinghouse type C motors. From the crusher floor the ore is lowered to the third level of the upper story, where it is stored in bins of 2,000 tons capacity. This entire upper story is divided vertically into three ohutes or compartments for the different kinds of ores—talcy, silicious, and arsenical—which are kept separate through the mill until they are finally mixed for the leaching tanks.



Motor Coupled to Hoist, Golden Gate Mill, Utah.

The second section of the mill contains two dryers, having a capacity of 500 tons per day, room being left for another dryer, in case the plant should be enlarged. The



Golden Gate Mill, De La Mar's Mines, Mercur, Utah.

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ore is worked over the floors of the dryers by rabbling devices operated by endless chains, and is there heated for about 2½ hours. In the third section the fine crushing and ore sizing is carried on. The machinery consists of four sets of 26 in. and three of 36 in. Cornish rolls, with a maximum crushing capacity of 1,000 tons per day; Berthelet apparatus for sizing; and a system of elevators for raising the crushed product to the separators. Six elevators are used, two to each of the three different classes of ore, and their lift is 60 ft. There are three separators for each class, that which is sufficiently fine passing through to the next section, while that which is still coarse is passed through the crushers until fine enough. The pulverized ore is finally collected in an ore-bin holding 2,000 tons. Under this ore-bin is a dust chamber, which is connected directly with the main flue, and is provided with hoppers spaced 12 ft. apart. The floor is so arranged that the dust collects at the mouths of these hoppers to be drawn off into the cars below.

The roasting of the ores takes place in Sections 4, 5 and 6. Four straight-line furnaces are used. The arsenical ores are crushed to about 10 mesh and discharged into two of the furnaces. The talcy ores are crushed to 4 mesh and roasted in the remaining furnaces. The silicious ores do not require roasting, but are emptied directly into the receiving hoppers below the roasters and mixed with the other ores while there, in proper proportions for the leaching tanks. The four roasters are contained in Sections 4 and 5, Section 6 being reserved for a possible future addition. The furnaces used for the arsenical ores have a daily capacity of 75 tons each; those for the talcy ores of about 150 tons each. The furnaces have their roasting hearths directly on the foundations, the calcined ore being elevated to the cooling floors above. The ore is stirred during roasting by means of V-shaped plows or scoops attached to rabbling carriages. These consist of I-beams mounted on wheeled carriers which run on tracks on either side of the furnace hearth. They are driven by endless cables, and are spaced 75 ft. apart, the cables running on sprocket-wheels. The ore is stirred and advanced by these motor-operated cables once each minute. One man attends to two furnaces. The gases are carried from the furnaces through 6 by 8 ft. flues into the main dust chamber, which runs from this section to a steel stack 8 ft. in diameter and 85 ft. high, located on the hill above the buildings.

From the furnace hoppers the ore passes through a tunnel to a point just above the tanks on the seventh section of the incline. This section has two floors, the main floor containing 10 tanks, each 25 by 50 ft. and 5 ft. deep, and three solution tanks, 20 ft. in diameter and 12 ft. high. The tanks are supported by masonry piers and a retaining wall. The ore from the tunnels is received in cars and run out by hand over the tanks, where it is dumped. The solutions filter through the bottom of the tanks, passing out to the precipitating tanks on the eighth level. When the liquor has been drawn from the tanks the tailings are carried out on cars which run from underneath the tanks to the waste dumps.

In the eighth or lowest section the gold is precipitated from the cyanide solution, drawn off from the leaching tanks, in three vats 14 ft. in diameter by 8 ft. high, containing zinc turnings.

The works contain, in addition to the departments already mentioned, a machine shop, warehouse, gas plant (in which water gas is produced for roasting and drying the ore), assay office, refinery and chemical laboratory.

About 100 ft. above the mill, the power-house, a one-story brick building, 25 by 70 ft., is located. Here are placed the Westinghouse motors for operating the hoist and motor-driven air compressors for the machine drills in the mine below. An electric hoist of 150 H. P. operates the cages for the ore in the two compartments, and one of 75 H. P. operates the cage in the manway. In addition to the above purposes, Westinghouse motors are employed for the main shaft blowers, centrifugal pumps, assay department, etc. The plant is operated entirely by two-phase induction motors, aggregating 700 H. P., all of the Westinghouse type C. The interior of the hoist room is shown in Fig. 3, with the large hoist. The hoists are direct-connected to 150 and 75 H. P. motors. There is also installed in this room a 150 H. P. motor direct-connected to an air compressor.

A 50 H. P. motor is used in driving the main shafting in the mill, while another of the same size drives the shaft for the roasters and the ore conveyor. The pump in the precipitation room is driven by a 20 H. P. motor. All motors are operated on a 24-hour load, and have been running continuously for the past two months.

The cost of the mill and equipment was about $400,000. The mine was described in the "Engineering and Mining Journal" for April 24th, May 1st and July 31st, 1897. At the time the Golden Gate mill was erected, some doubt was felt as to whether the electrical machinery would be found adequate for the heavy work of the plant. It has turned out, however, that the electrical apparatus is the most trustworthy and reliable part of the equipment. If a crusher becomes clogged, it is usually the case that a belt or gear will give way before the motor becomes stalled.

A NEW PROCESS OF COLORING LEATHER BY THE AID OF ELECTRICITY.—A modification of the ordinary brushing process has recently been introduced in Germany, quotes the Textile Journal of Bombay, and in this method of dyeing the zinc-covered table upon which the hide or skin is placed forms the positive pole for the generation of an electrical current for inducing a certain reaction. The fluid dyeing material is poured upon this table, and the negative pole is then connected to the leather. Under the action of the current, the coloring matter penetrates the immediate surface of the leather, and the intercellular fixation and distinction is said to leave nothing to be desired. Patterns may be made upon the leather by covering it with an ordinary stencil system, and on connecting these plates to the negative pole, the desired representations are formed.

FRANK J. SPRAGUE GETS A FAR-REACHING DECISION AGAINST NASSAU COMPANY.—Justice Lacombe, sitting in the United States Circuit Court for the Eastern District of New York, yesterday handed down a decision which will cost the Nassau Electric Railway Company a million dollars in money, and which may, in the process of its going into effect, materially interfere for a time with the ability of the Nassau lines to render schedule service.

The decision was on a motion of Joseph P. Ord, et al., assignees of certain patents granted to Frank J. Sprague, covering the form of electric motor used on nearly all the cars of the Nassau lines. The motion asked for an injuction to stop the infringement of Sprague's patents by the defendant company.

Judge Lacombe granted the injunction asked, and orders the Nassau Company to remove the motors now used to propel its cars. The order provides that 250 motors shall be removed within thirty days from the date of the order's issuance; 250 more within sixty days and all remaining motors within 120 days.—Ex.

EFFECT OF ARMATURE INDUCTANCE UPON THE ELECTROMOTIVE FORCE CURVES OF AN ALTERNATOR.

(Concluded from page —.)

Over-Compounding.

It was noticed during the test that the armature reaction caused an increase in the total effective potential for certain ranges of load.

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This phenomenon has been noted by other writers, and in his paper before the Institute, already referred to, Steinmetz has pointed out an explanation for it. Curve A of Plate 17 is the external characteristic of the dynamo, with constant field excitation, and coils 1 and 2 alone in action. The curve was plotted from the readings of a Weston voltmeter and a Siemens dynamometer connected in the external circuit. The load was a non-inductive one, and the speed of the dynamo averaged 1,450 r. p. m., which is equivalent to a frequency of a little over 24 periods per second.

The line R represents by its slope the resistance of the two coils, and curve B, which was obtained from the sum of the ordinates of the curves A and R, is the total effective E. M. F. characteristic of the coil. It will be noticed that the curve B shows an over-compounding effect up to a load of 7 amperes, and that the total effective E. M. F. was a maximum for a current of 4 amperes in the coils.

The term "armature reaction," as used above, is not intended to convey the idea that the current in the coils has any effect in varying or modifying the intensity of the flux passing through the field spools. The influence of the M. M. F. of the coils is purely a local one, and the paths traversed by the flux which it induces are confined to the air-gaps, poles and armature core. The influence of the armature inductance upon the flux density in the cores of the field spools is negligible, as a careful exploration established the fact that the field current was perfectly constant.

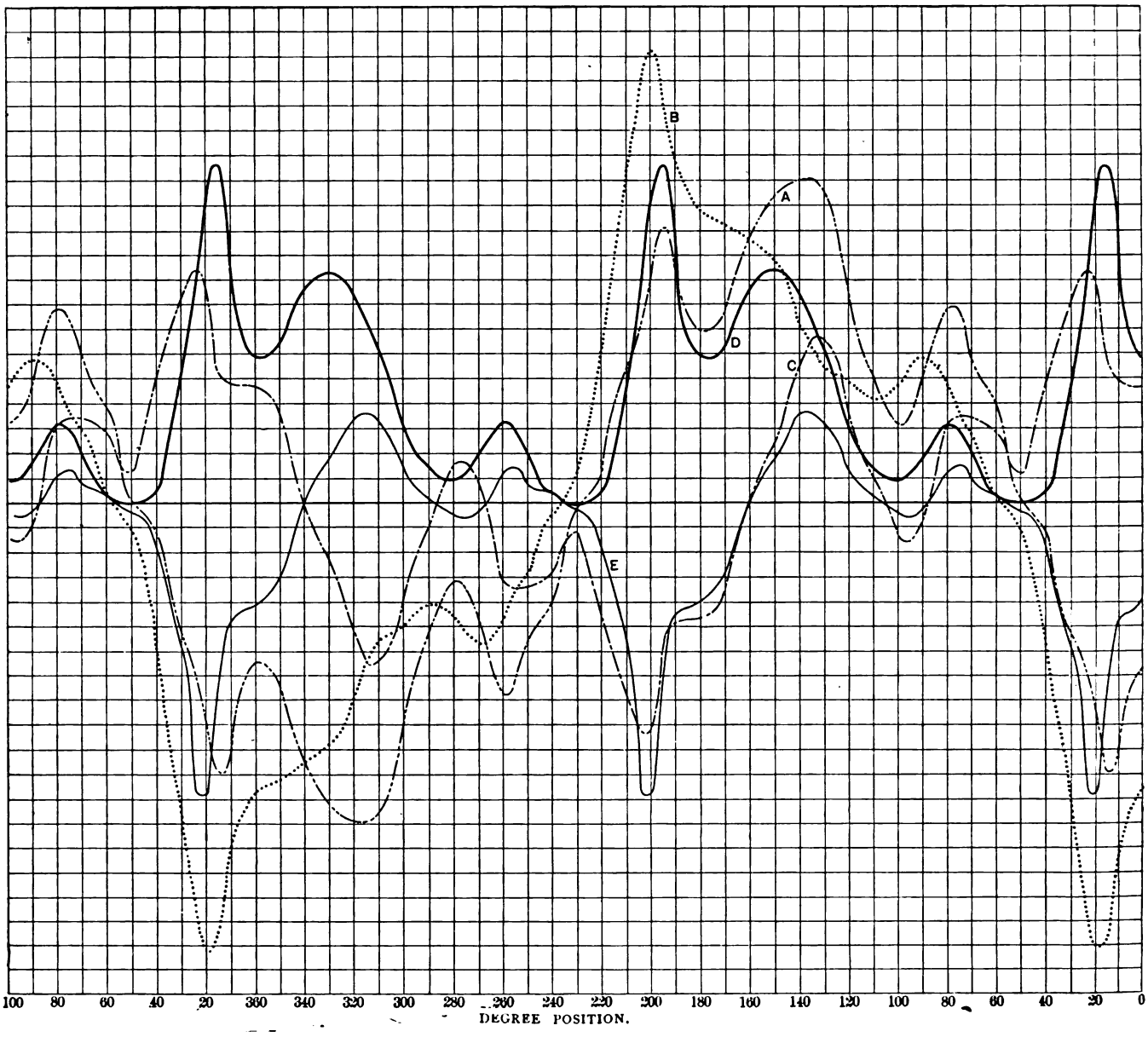

Plate 18.

A = Eundamental E. M. F. wave.
B = Total effective E. M. F. curve and current curve.
C = Counter E. M. F. curve.
D = Fundamental E. M. F. power curve.
E = Counter E. M. F. power curve.
The total power developed is represented by vertical distances between the curves D and E.

The compounding action of the armature currents in augmenting the effective voltage is a matter with which you are doubtless familiar. As a matter of interest, however, and in order to present a better picture of the wave forms involved, a series of curves has been plotted that includes the power curves and enables us to more readily appreciate the cycle of events that combine to produce this result. In Plate 18, curve A is the fundamental E. M. F. wave; curve B is the total effective E. M. F. wave and also represents the instantaneous values of the current; and curve C is the counter E. M. F. wave. Curve D is the power curve of the machine determined by taking the product of the corresponding instantaneous values of the current and the fundamental E. M. F. curve. Curve E is a power curve obtained by taking the product

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of the corresponding values of the current and the counter E. M. F. The power curve of the total power developed by the machine, and which is proportional to the product of the corresponding values of the current and effective E. M. F. curves, is not plotted, as its ordinates are proportional to the square of those of curve B, and

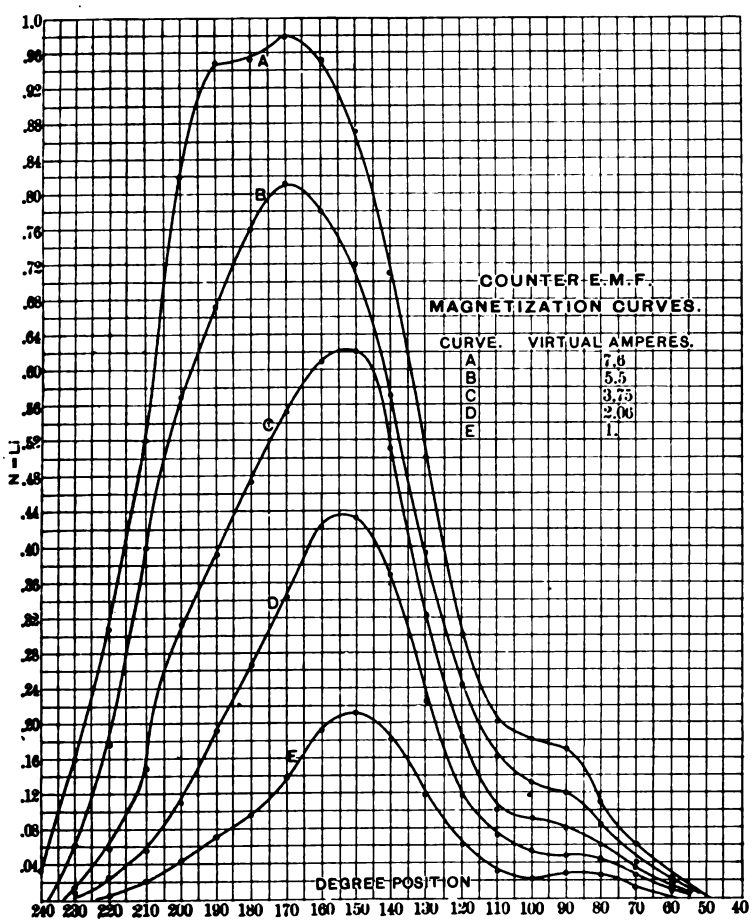

Plate 11.

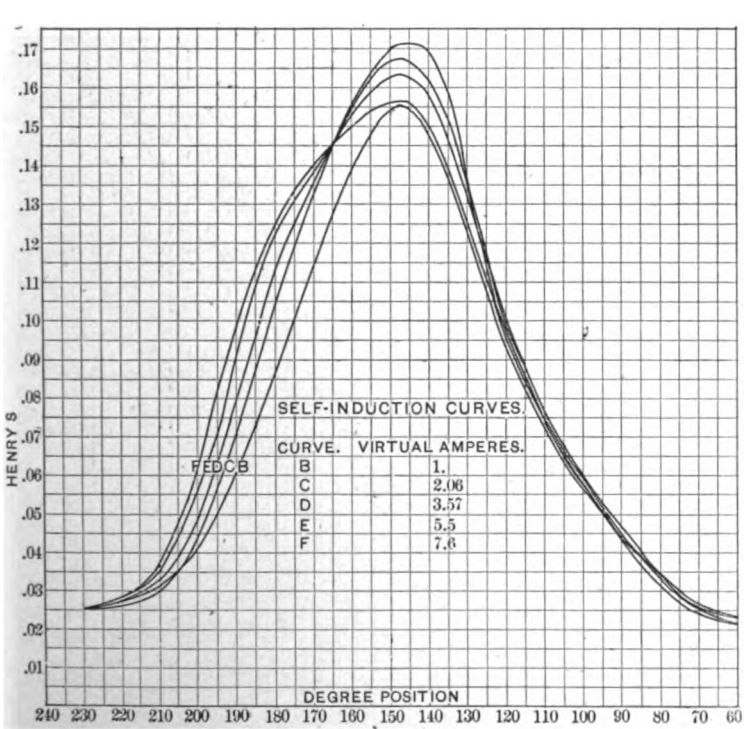

Plate 10.

*J. A. Fleming, "The Form Factor of Alternate Current Curves." London "Electrician," vol. xxxvi., p. 338.

equal to the vertical distances intercepted between the power curves D and E.

It will be noticed that the power area inclosed between

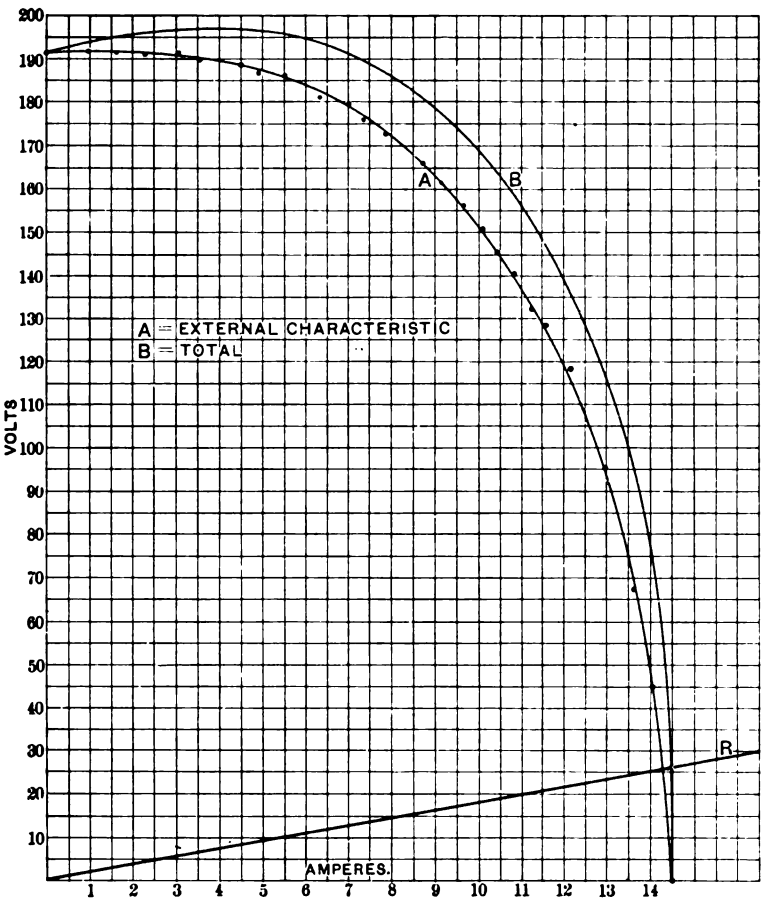

Plate 17.

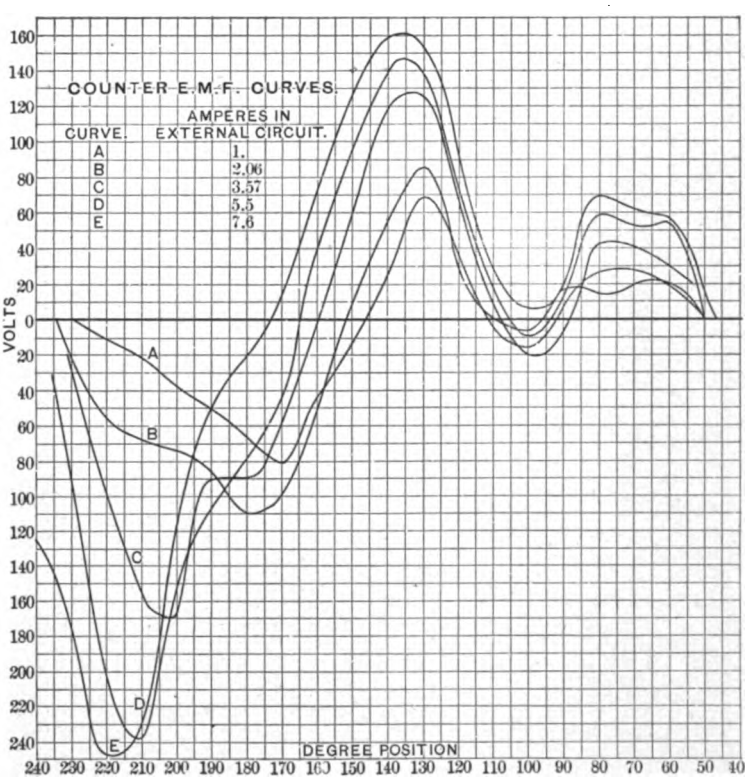

Plate 14.

the curve E and the base line changes sign four times in a complete period, owing to the irregular form of the curve C, and that the sum of its positive and negative areas is not zero, but equal to a negative quantity.

Positive work done by the counter E. M. F. indicates

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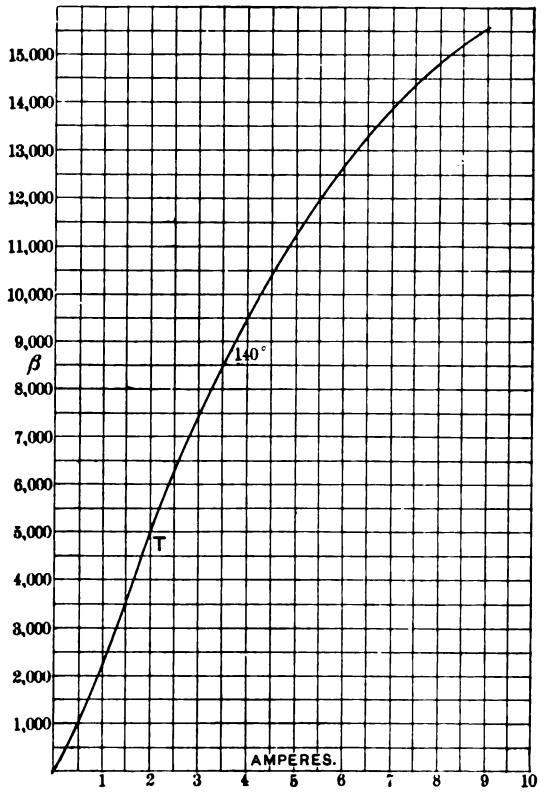
power absorbed from the circuit. The energy consumed in overcoming the hysteresis and eddy current losses in transformer cores is a familiar example of this fact. Negative work performed by the counter E. M. F. in the same way represents power given to the circuit. In the present instance the negative area is due to a peculiar combination of irregular wave forms, involving the inductance curve, the current curve, the curve of the magnetism inducing the counter E. M. F., and the curve



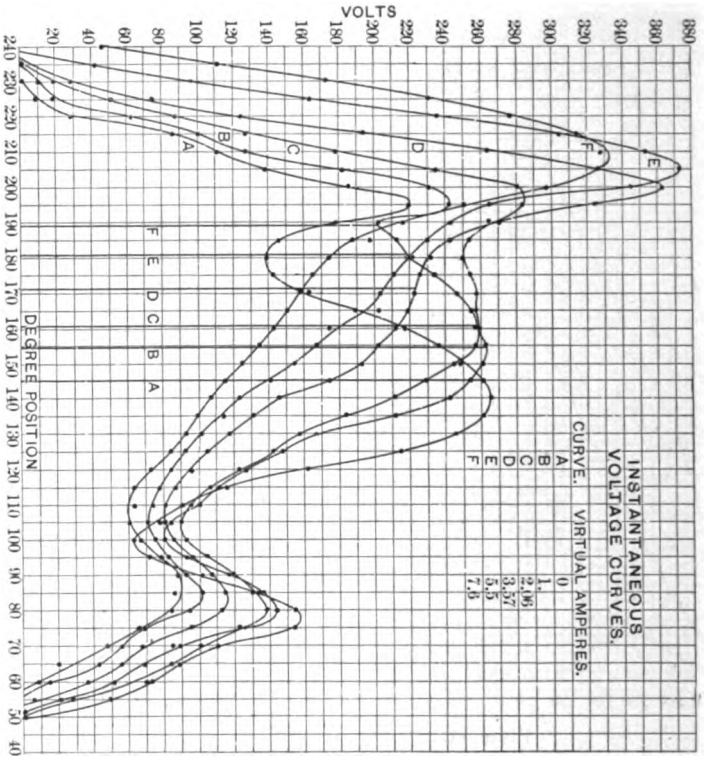


Plate 6.

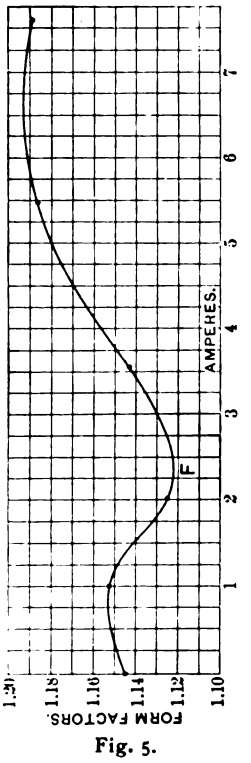


Fig. 5.

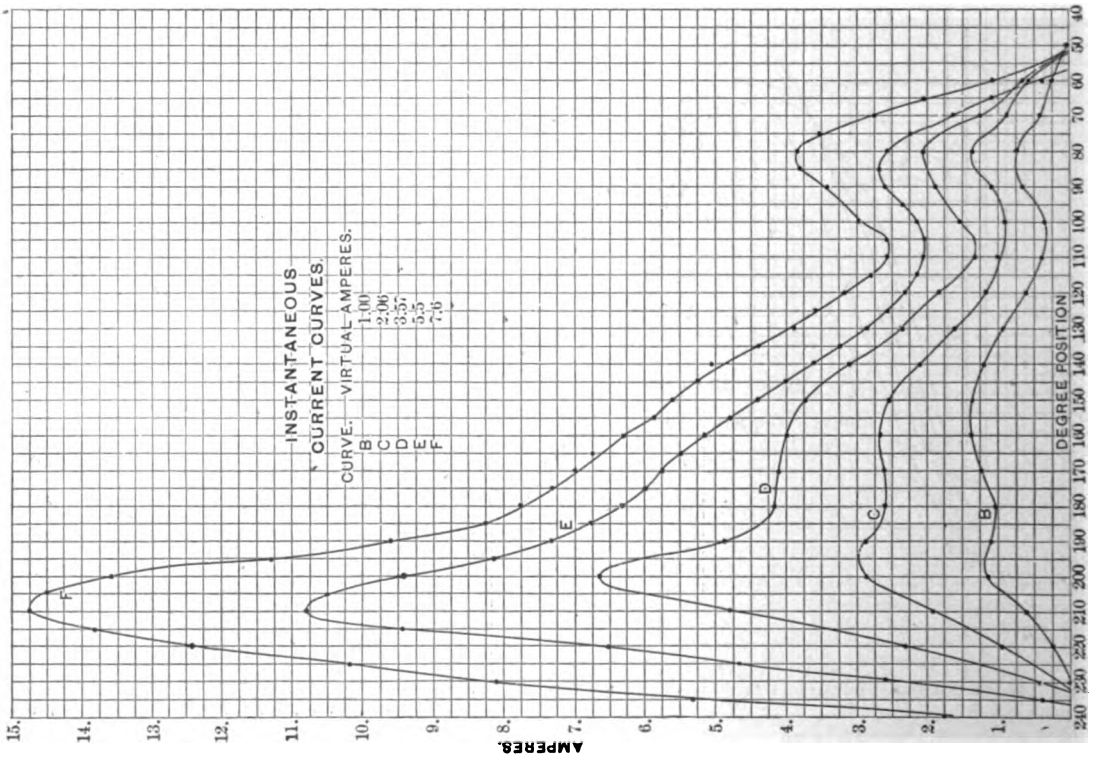


Plate 9.

of counter E. M. F. The peaks of all the curves are shifted more and more in the direction of rotation as the load comes on, but some are given a greater displacement than others. The peak of the current curve, for instance, lags behind the peak of the inductance curve. In other words, the current is a maximum when the inductance is least.

This results in the production of a wave of M. M. F. of self-induction that is in advance of the current, and that produces a wave of magnetism in the coils which reaches a maximum midway between the peaks of the inductance and current curves. These phase relationships can be followed out by comparing Plates 10, 9 and 11. The wave of inductance magnetism (curve A, Plate 11) induces a curve of inductance E. M. F. that has an effective phase displacement behind the current wave of less than 90°. This makes the effective phase displacement of the counter E. M. F. curve (curve C, Plate 12, and curve C, Plate 18) more than 90° in advance of the current curve,

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THE ARC LAMP FOR HOME ILLUMINATION.

The illuminant most popular in New York city, mainly on account of its cheapness, is gas. That which holds second place, though far superior in convenience, is electricity. The use of electricity at home for illuminating purposes is being seriously considered by the great companies supplying light and power in different sections of the city. The incandescent lamp is universally recognized as the most satisfactory source of illumination that can be employed for domestic purposes, and its use in consequence of these qualities has become widespread. But the signal success of the incandescent lamp is being encroached upon by a lamp which possesses features of similarity and yet of absolute difference. The lamp to which we refer is the enclosed arc lamp, whose life is already one-quarter of that of the incandescent lamp, and its illuminating power and efficiency much greater. The enclosed arc lamp is a hybrid type. It would in many respects suit the ideas of those desiring a strong white light in the home, if the same is already equipped with an electric light plant of large or small dimensions. From an efficiency standpoint, the arc lamp is undeniably in advance of the incandescent lamp, but the difficulty of making arc lamps of low candle power which would require but little attention has been too great to allow of a comparison between the two in the home.

The final adoption of the enclosed arc lamp for street lighting and in many cases for interior illumination has made several manufacturers attempt the construction of small lamps which would meet the commercial requirements satisfactorily. These lamps, if only burning through an interval of seventy-five hours, would prove a valuable addition, in the respect that their cheapness of operation and unusual brilliancy would from an economic and hygienic standpoint be a means of making them an indispensable element of home comfort. The worthy inventor of a one or two hundred candle power arc lamp of the latest design, burning for a period of fifty, seventy-five or one hundred and fifty hours without attention, will find a broad field for its introduction and, without doubt, profits accruing from the sale of them which will add greatly to his material interests.

The present enclosed arc lamp is used in conjunction with a thick and rather substantial pair of carbons. A smaller lamp provided with thinner, though not necessarily longer carbons, would burn at a lower pressure with less current and give a light of remarkable brightness. The past experiments of the inventors of the enclosed arc lamp have shown them clearly that in its present form power consumption has been sacrificed to life, and the candle power obtained for a given wattage is less than we find in the ordinary old-fashioned form of arc lamp. A small enclosed arc lamp which will automatically feed itself with carbon pencils as required, represents a future innovation which would exercise a remarkable influence upon the opinions of those still in doubt as to the advantages, economy and unequalled convenience obtained by the use of electricity for home illumination.

LIGHTNING DISCHARGES AND HIGH FURNACES.

The invention of the lightning-rod has doubtless saved many lives and much property from destruction. The efficacy of the lightning-rod has been for many years a subject of discussion on account of certain cases brought forward that antagonized a belief in their universal serviceability. Strange as it may seem, the German scientists have discovered, during a series of observations, that furnaces and buildings provided with high chimneys are not protected from lightning discharges even though equipped with lightning-rods. Chimneys that have the bad habit of smoking are very likely to be the seat of a static discharge because of the smoky particles providing a circuit to the ground. In all probability the theory, which is rarely explained, that it is dangerous to sit near a fireplace during a thunder-storm, may find its foundation in this phenomenon. A heavy smoke composed of carbon particles is in many respects a much better conductor of high potential oscillatory discharges than a solid metallic rod. One of our best known electrical engineers once suggested the use of lightning-rods composed of short segments separated from each other by air gaps. This idea is somewhat faithfully carried out in the use of a smoke column for a lightning-rod. Although from a scientific standpoint the reason why high chimneys are struck may be attributed to the fact that their elevation and consequent nearness to the charged body (the cloud), acting inductively upon them, brings about a condition of higher potential, it seems also likely that the escaping smoke adds greatly to the danger of a powerful electrical discharge being precipitated on the chimney itself. The summer season is well on by this time and the frequency and intensity of thunderstorms apt to increase. This will be thoroughly appreciated by the fortunate possessors of summer homes, isolated from other buildings of any size or consequence. The protection of these structures from injury is better guaranteed, however, by the use of lightning-rods than any other means man has as yet devised, and we would advise our friends at the seashore and country to make provision for such a probability.

The percentage of fatal cases resulting from lightning discharges is about one one-thousandth of a per cent. or about one in a million.

The safest buildings are, of course, those built with an iron framework; wooden structures are never exempt from the risk of injury by a lightning stroke. The serious and often fatal results of negligence in the erection of lightning-rods have called and will call attention to the necessity for using rods properly erected and of a reliable construction.

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and therefore the product of the instantaneous values of the counter E. M. F. and current curves gives a power curve having an excess negative area. It is rather difficult to estimate the phase position of a wave that has an outline as irregular as that of the curve C of Plate 18, but it is best approximated by noting the location of its greatest positive area, and this, in the case in hand, is early in each half period.

Conclusions.

An inspection of curves B and D of Plate 18 shows that any decrease in the maximum slant of the curves of Plate 11 will decrease the amplitude of the 200° peaks of the counter E. M. F. curves, and thereby decrease their form factors, and at the same time decrease the form factors of the effective E. M. F. curves. This is what occurs in the case of curve D of Plate 11, owing to the great amplitude of the inductance loop for a value of the current of two amperes, which also accounts for the drop in the "form factor curve" of Fig. 6. This curve represents the form factors of the E. M. F. curves of Plate 6, and of the current curves of Plate 9, plotted relatively to the virtual value of the current flowing in the coils at the time the curves were taken. The form factors have been calculated according to Fleming's* definition, which is that the form factor equals the ratio of the square root of the mean square of the ordinates of the wave to the true mean ordinate of the wave.

The influence of the inductance of the coils upon the form factor can best be appreciated by looking at the curves of Plate 10. They all have the same width of base, but vary in amplitude, and necessarily other things being equal, produce counter E. M. F. curves having the smallest form factors when currents which are favorable to a large armature inductance are flowing in the coils.

It is noticeable that the right sides of the curves of Plate 10 all have the same slant. They therefore produce counter E. M. F. loops having similar shapes (see Plate 14). On the other hand, the left sides of these curves vary in shape, owing to variations in reluctance at this part of the cycle. Greater variations, therefore, occur in the instantaneous values of the counter E. M. F. induced in this part of the cycle than in the former part, with the result of increasing the form factor where the induction curves corresponding to the current curves are relatively low and broad, and of decreasing the form factor of the counter E. M. F. curves where the inductance curves are narrow and high.

Again, since the maximum peak of the effective E. M. F. curve is opposite in sign and position to the leading peak of the corresponding counter E. M. F. curve, and since the sum of these peaks must not be greater than the adjacent peak of the fundamental E. M. F. wave, we see that an increase in the form factor of a counter E. M. F. curve causes an increase in the form factor of the corresponding effective E. M. F. curve, and vice versa. That the changes in the form factor of the effective E. M. F. curves are approximately directly proportional to the mean width of the inductance loops, and inversely proportional to the amplitude of the inductance loops. These conclusions are amply sustained by the data presented.

The variations that take place in the value of the armature inductance when the load is increased, lead us to expect that there is a proportionally greater increase in the value of the counter E. M. F. as the current passes 2 amperes in value. An accelerated increase in the counter E. M. F. would have the effect of making the compounding proportionally greater, for it would add a proportionately greater amount of energy to the circuit, owing to the fact that although the amplitude of the counter E. M. F. is increased, its phase position remains practically the same. That a positive acceleration does occur in the rate of increase of the counter E. M. F. is true, and also, that this is followed by a negative acceleration. The value of the counter E. M. F. depends upon the intensity of the current, and increases as the current increases. It, however, does not increase at a rate that is proportional to the rate of increase of the average intensity of the current, for its value also depends upon the armature inductance which first increases to a maximum and then decreases, as is shown by the curves of Plate 10. We, therefore, find that as the average intensity of the armature current is uniformly increased, the counter E. M. F. experiences a proportionally greater rate of increase up to a certain point, and that after this point is passed its rate of increase is diminished.

This means that as the load comes on, the value of the effective electromotive force increases above the value of the fundamental wave for a time. For from the relative positions of the highest peaks of the curves B and C of Plate 11, it will be evident that any increase in the virtual value of the counter E. M. F. will cause the virtual value of the effective E. M. F. to increase also, and any increase in the virtual value of the effective E. M. F. above the virtual value of the fundamental wave of E. M. F. raises the potential at the brushes. The fact that the virtual value of the effective E. M. F. finally falls below that of the open circuit E. M. F. is due to the ultimate gradual decline in the armature inductance wave and a consequent change in the form of the counter E. M. F. magnetization curve, which reduce the amplitude of the leading peaks and augment the amplitudes of the trailing peaks of the counter E. M. F. curves. This effect is apparent in curves D and E of Plate 14.

As exemplified in the curves of Plate 7, we find that the maximum induction threading the armature coils occurs when the form factor is least, and the armature inductance greatest. Again, the analysis of the forces involved shows us that the point F on the form factor curve of Fig. 6 and the point T on the "B & H curve" of Fig. 5 are intimately connected.

The double role played by the permeability of the iron of the armature core and pole-pieces, and the importance that may be attached to the permeability of the iron under favorable conditions is forcibly brought to our minds. We are enabled to see a little more clearly the complex relations of the interlinked forces that act and react upon one another in the conflict of the air-gaps, and there is established a basis for the analysis of a problem that has been more or less obscure.

Purdue Uuiversity, Lafayette, Ind.,
June, 1897.

COLT'S MACHINE GUNS. — The principle of the Colt guns, the very latest weapons of modern warfare, gives no hint of their murderousness. A three-foot blued heavy barrel with a pistol butt and trigger and a calibre, the size of a pea, this barrel fitting into brass pivots that permit a sweeping aim, up, down or around—that's all. Yet through that little aperture, smaller than a baby's finger, are projected invisible death engines that would cut platoons of men in pieces. The gun is literally a death buzz saw when swept slowly from right to left and left to right. If held stationary for a moment the discharge assumes the force of a shrapnell shell that never stops, and ordinary torpedo boats may be sunk by its force. By the side of the barrel is a wooden box. In this 1,000 Lee rifle cartridges, with the small calibre steel bullets, charged with smokeless powder, are coiled on a tape, like an endless cartridge belt. The end of the tape is pulled sidewise through the gun, the trigger is pulled, and then the gun shoots, ejects the loads without further human agency. After that the gunner simply directs the sweep of fire. A few inches from the muzzle is a vent down into a chamber underneath in the barrel. At the first discharge a small percentage of the gas proceeds through this vent, forces out a lever as the marksman's hand forces down the lever of a Winchester rifle, and this flying lever in turn propels the mechanism, and as the

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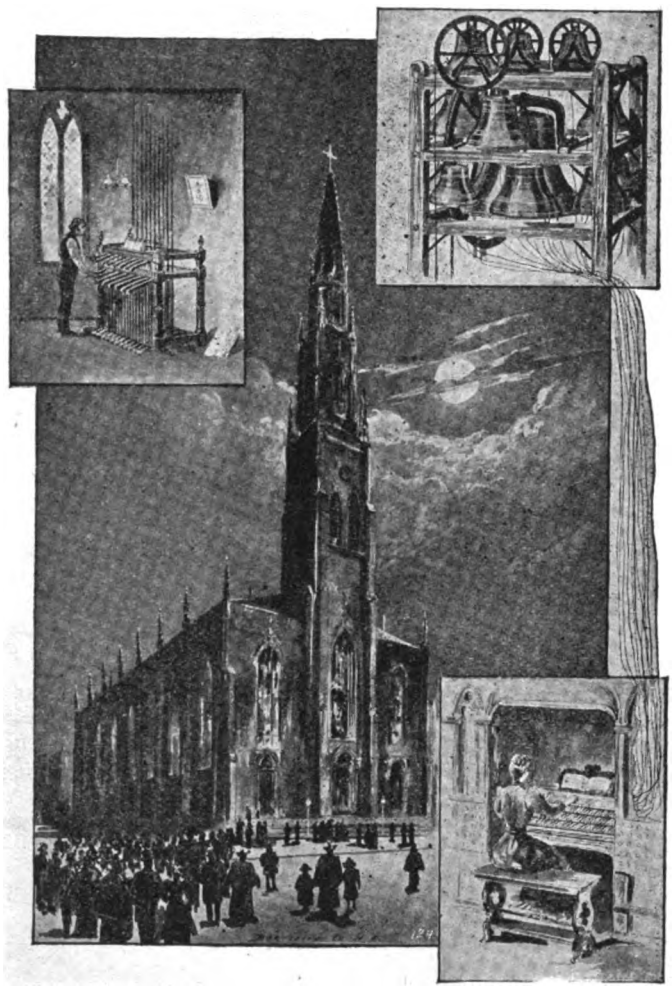
spent cartridge is ejected, another is drawn in and struck by the hammer. In an instant the gun pours bullets like a stream from a hose, each cartridge exploding the next, at the speed of 200 a minute. Directed at a file of men up to 700 yards the effect is terrific, for the bullets of steel, that look like tiny pencils, will go through six men. Some time ago Lieutenant Pond tried the gun at the New York navy yard. He had twenty inches of oak and a three-eighths inch steel plate. To make sure, he added another one-eighth inch plate. Then he couldn't find the bullets. Upon search he found that they had gone through the twenty inches of oak, the three-eighths-inch steel plate, the one-eighth inch steel plate, two sides of an old iron boiler and the brick walls of the building.—Boston Journal of Commerce.

A NEW ELEMENT IN AIR.—According to a London letter, Prof. Ramsay, the joint discoverer with Lord Rayleigh of argon, has, with the assistance of Mr. Morris Travers, eliminated from the atmosphere a new gas, which he calls crypton. According to a communication made to the Academie des Sciences in Paris, through M. Berthelot, the discoverers received from Dr. Hampson 750 cubic centimeters of liquid air, which they reduced by evaporation and collected in a tube. A gas was furnished by the residue. This gas was deprived of its oxygen by the help of metallic copper, and of its nitrogen by the action of the electric spark, and of its oxygen after that by a mixture of magnesium and pure lime. This effected, there remained 26 cubic centimeters of gas, which presented, besides a weakly defined spectrum of argon, an additional spectrum till then unknown. It was characterized by exceedingly brilliant lines, one almost identical with D_3. The other green may be compared in intensity with the green line of helium. Its wave length was 5,566. 3. Another slightly weaker gave 5,557. 3. The density of the gas was approximately 22.5, that of oxygen being 16. It is believed that the new gas is monatomic and constitutes an element. These facts go to prove that the atmosphere contains a hitherto unknown gas heavier than argon and with a characteristic spectrum less volatile than nitrogen and oxygen and argon.

Prof. Ramsay was unable to absolutely determine its position in the periodic system. He, however, hazards the conjecture that the pure gas has a density of 40 and and an atomic weight of 80, and that it may be classed with helium. The investigations are being continued, and a larger quantity of the gas is being prepared.—"Engineering and Mining Journal."

Mitchell, S. D.—The electric light plant destroyed by fire at a loss of $5,000; no insurance.



Electric Chimes, St. Alphonsus Church, Baltimore, Md. Equipped 1893.—Crocker-Wheeler Electric Company.

NOVEL APPLICATIONS OF ELECTRIC LIGHT AND POWER MACHINERY.

A visitor to Baltimore, Md., will find the church of St. Alphonsus equipped with electrical apparatus for the operation of its machines. The silvery tones that echo through the air on Sunday morning are produced by means of an electric keyboard which operates the bells with absolute certainty, and such nicety that the blow given is either pianissimo or forte. The electric chimes pealing through the city awaken in but few minds a sense of the uniqueness of the cause by which these tones are produced. Not alone is electricity used for ringing the bells, but in addition it is made use of for pumping wind into the organ.

Some day in the future, places of worship will be connected to the home by wire, enabling those incapacited from attending service to hear it in the privacy of their own chamber and possibly (though the chance at present seems remote), of actually seeing in a lifelike manner the

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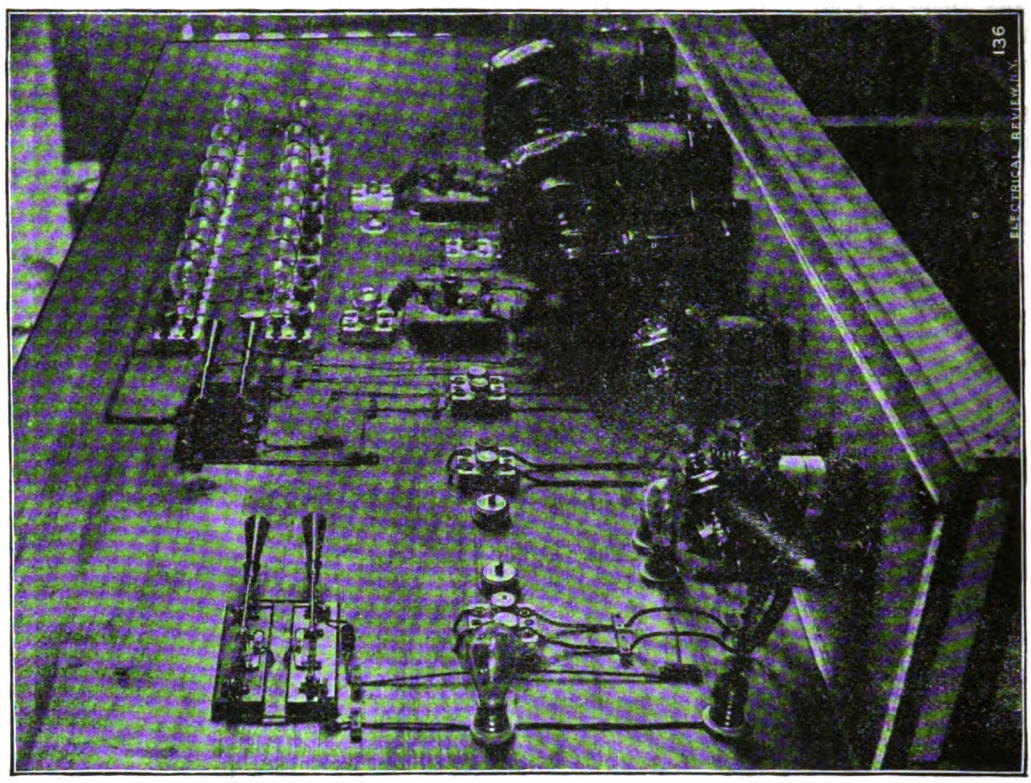
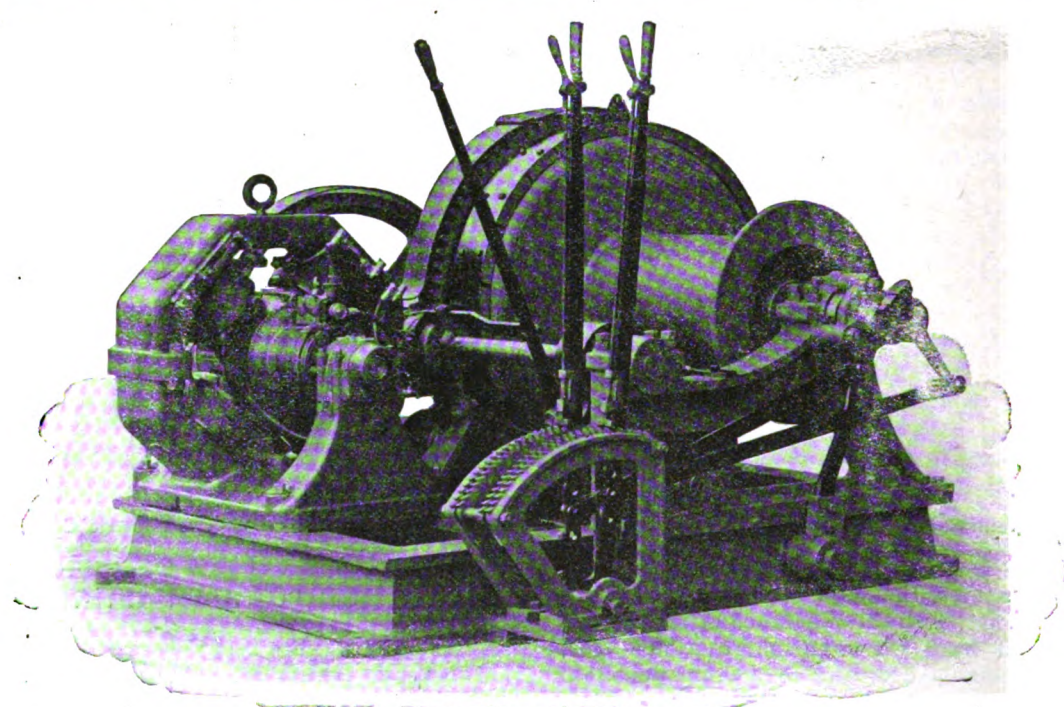
pastor, the audience, and, in fact, the whole church interior.

Edward Bellamy, in his famous novel entitled "Looking Backward," touches upon such a scheme and dates it only one hundred years hence, so the time cannot be very far off in the light of our present progress. In the large central offices of telephone companies, a peculiar application of the motor transformer is made for the purpose of raising and lowering the pressure to suit the requirements of the outside line. Not only do we find small machines in use here, but also for telegraphic service.

The Western Union are at present operating their quadruplex system by means of small dynamos in place of batteries. The motor is being introduced very rapidly into the home, so that it has become by this time a familiar feature in large apartment houses and those of hybrid type, half hotel and half flat. Its use for elevator service, and, in fact, for all sorts of hoisting purposes, has become quite general. The advantages of a motor for either of these purposes makes it far superior to the hydraulic or steam system.



Battery of Dynamotors for Telephone Centrals.



Size 15 Motor and Crook Dock Hoist.—Crocker-Wheeler Electric Co.

One of the most interesting applications of electrical machines is found in the use of small direct-connected electric-light plants. A Case engine in connection with a Crocker-Wheeler motor, mounted on a small bed plate and occupying but a corner of the room or basement in which the switchboard is situated, has proven a cheap and simple means of producing electricity for light, heat and power in a small way. Many private homes, the owners of which look with disfavor upon any bulky apparatus

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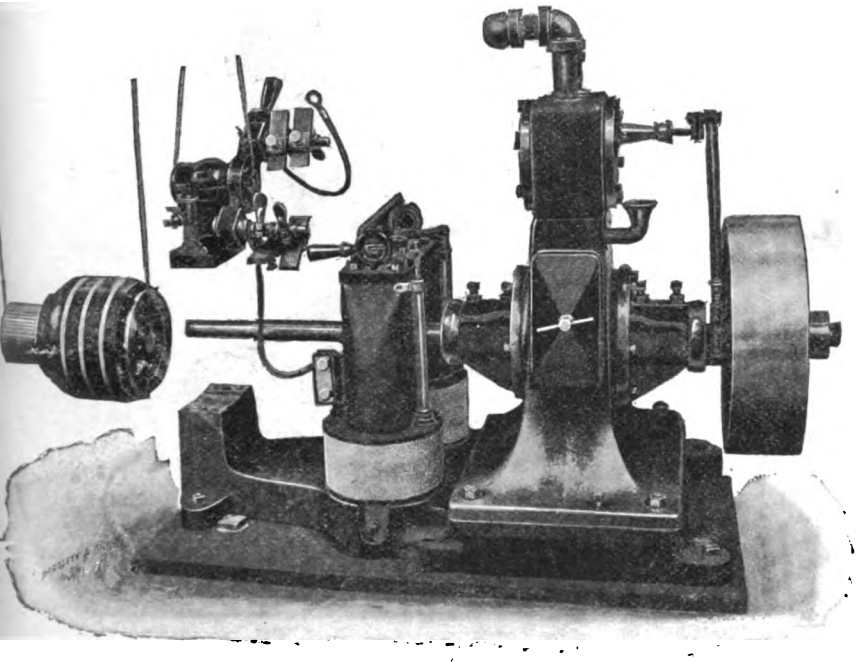
they may have occasion to use, admit that a small electric-light plant of this description proves itself so great a convenience that under no consideration would they part with it.

The trade carried on at present by manufacturers of electrical machinery is not one-tenth of what it will be when the great masses are fully awake to the wonderful advantages its use implies. Every home should have electric light, fans, heating and cooking apparatus, and it will not take many years for such so-called innovations as these to become an article of ordinary domestic use, familiar to all those in possession of their own homes.

NET MADE OF SPIDER WEB.—An especially fine net, made entirely of spider's web, is being manufactured, says Textile America, in the professional school at Antananarivo, Madagascar. The process is a very simple one. Thread of several dozen spiders is wound on winders, the quantity produced by each spider ranging from fifteen to forty yards. The covering of the web is removed by repeated washing, and the web made into a thread of eight strands. When the thread is spun, it is easily woven into a gauze, which is very fine, but very strong.

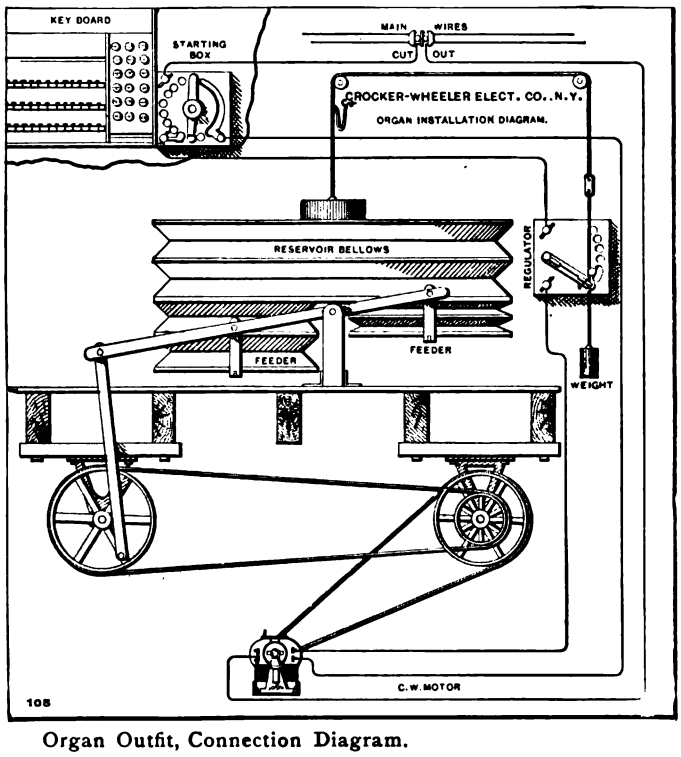


Size 3 Dynamo and No. 3 Case Engine, Disassembled.

It may seem paradoxical to say that the electrolytic methods of the future will differ altogether from those which are at present applied to electro-deposition. But there is no reason to believe that the continuous current is the only one fit for electro-chemical purposes. Not very long ago the alternate current and high tension were looked upon with diffidence, even by electricians of universally recognized ability. They reign to-day, nevertheless, and electric lighting, transmission of power, etc., could not in many cases be effected without making use of them. Why should we not assume that we may leave on one side the old electrolytic system, and adopt a new one based on the action of alternating currents and of high tension, in order to obtain in much less time and at a considerably cheaper rate some results with which the continuous current, at present actually used for electrolysis, could not compete? Swan has overruled the laws of electroplating by the use of weak currents, and deposited copper at the rate of 1,000 amperes per square foot of electrode; Wm. Crookes has already treated auriferous ores by the alternating current; their example has now been followed in quite a new direction, and there is no temerity in predicting, as an evolution in the application of electrical energy to the separation of metals and to the winning of gold, the use of high tension currents for electro-deposition.—E. Andreoli, in the "Engineering and Mining Journal."

A NOVEL, UNIVERSAL ELECTRO-PLATING OUTFIT.

The art of electro-plating has always possessed more or less fascination for the amateur and dabbler in electricity, but on account of the uncertain results obtained through not properly compounding the solutions used, and the expense of materials required in the various, stages it has been reluctantly dropped as being not quite within reach. The "Model Electro-Plating Outfits," manufactured by the U. S. Electro-Chemical Company, of 127 Crosby street, New York city, will therefore be hailed with a good deal of satisfaction by the hitherto unsuccessful electro-plater.



Organ Outfit, Connection Diagram.

As mentioned above, the chief difficulties in the path of successful plating were caused by not properly compounding the various plating solutions or baths. As the success and quality of the deposit depends entirely upon the solution, it will be seen that the same needs a great deal of care, skill and attention. These difficulties are, however, overcome by the use of the "U. S. E. C. Co. Electro-Plating Salts," which require only the addition of water to be ready for immediate use; no cyanides, chlorides, nitrates, etc., being necessary. The salts are manufactured in gold, silver, copper, brass, oxide, tin, etc., and are dry preparations, thus enabling the plater to mix up any desired quantity. The amateur is thus relieved of all apprehension regarding the quality of his plating bath. These "Model Electro-Plating Outfits" contain everything required for plating, such as tanks, brushes, rouge, saw-dust, lime, wire, etc., besides a full and complete book of instructions, which explains every step in the various operations, and enables the amateur to do just as good plating as the expert.

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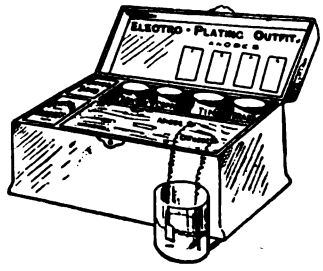
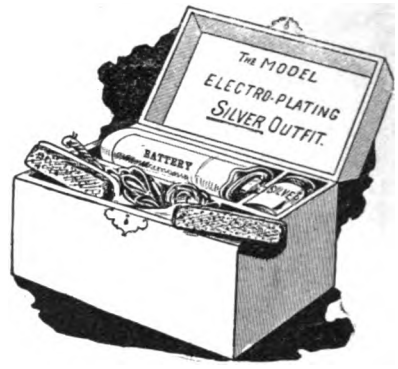
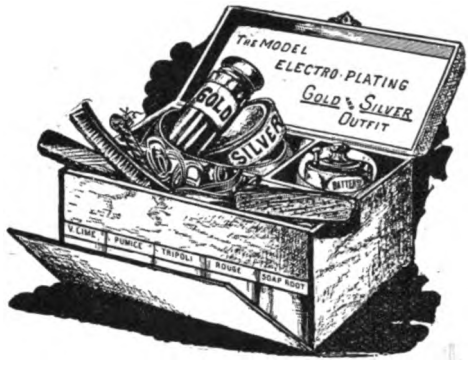
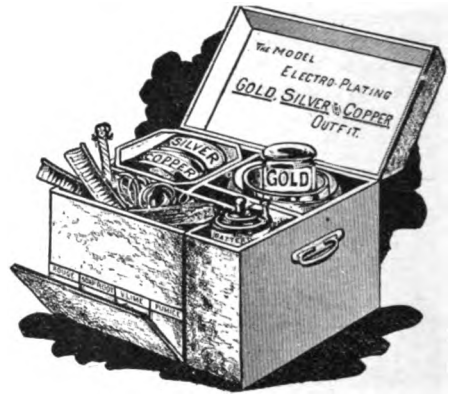
The outfits are manufactured in various styles and sizes, as will be seen in illustrations, the prices ranging accordingly, and are meeting with great success, not only among amateurs, but professional platers as well, to whom the simplicity and ease of operation with these outfits appeal strongly. The company have received a number of testimonials from large firms throughout the country using their salts, and they all agree as to excellence and quality of the same. Circulars describing the various outfits can be obtained by writing the company at the above address, and we would advise those of our readers interested in plating to write for further information.









Model Electro-Plating Outfits.

Mena, Ark.—The Mena Telephone Co. has been incorporated by H. M. Quigley, Edward Kerogh and J. S. Kelley. Capital stock, $5,000.

Lawrenceburg, Ky.—George W. Dyer, of Princeton, Ky., has been awarded contract to supply the city with electric lighting.

Lancaster, Pa.—The Lancaster Electric Light, Heat and Power Co. held a meeting of stockholders recently, and decided to increase capital stock from $150,000 to $250,000, and also to issue bonds to the amount of $100,000 for the purpose of enlarging plant.

Elmer, N. J.—City Clerk may be addressed concerning the erection of electric light plant.

Mansfield, Mass.—F. L. Cady can give information concerning construction of electric-light plant.

New Berne, N. C.—The Henderson Telephone Co. has purchased the New Berne Telephone system, and will expend several thousand dollars in improving same, putting in new switchboards, cables, etc.

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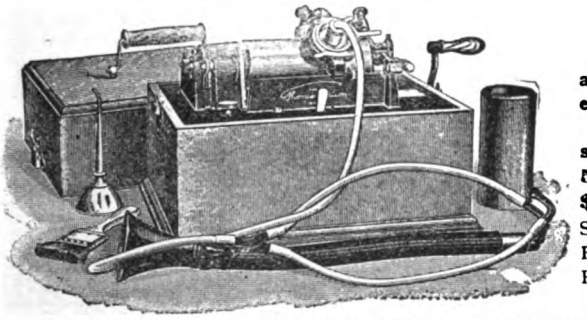

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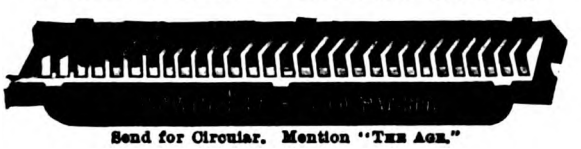

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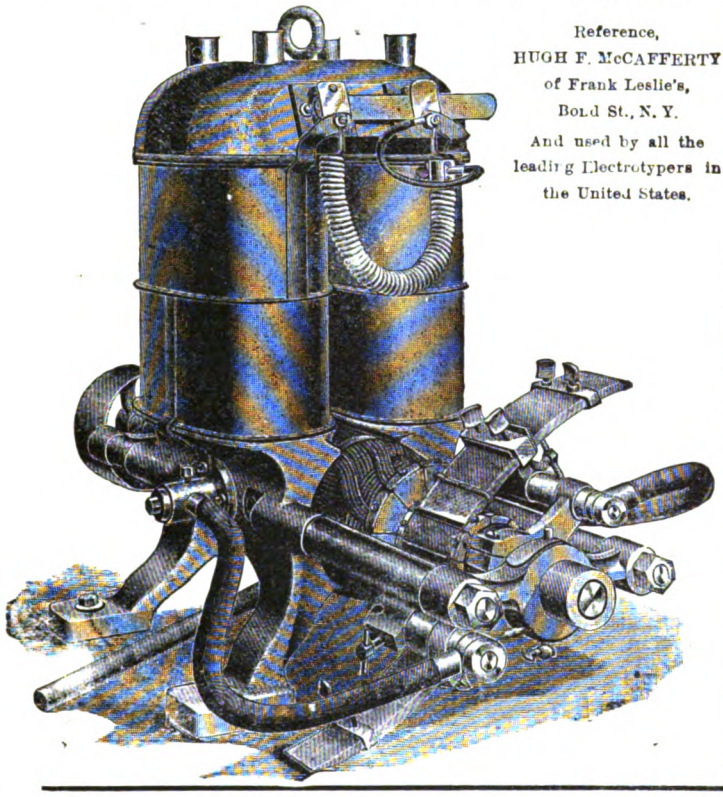

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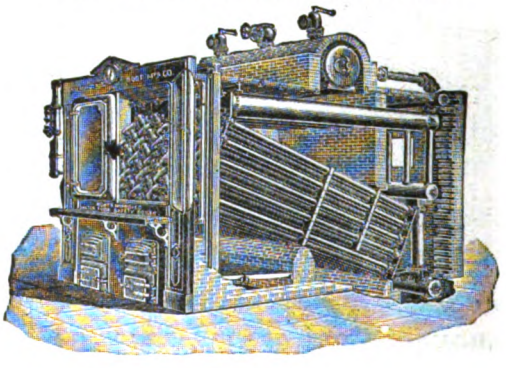

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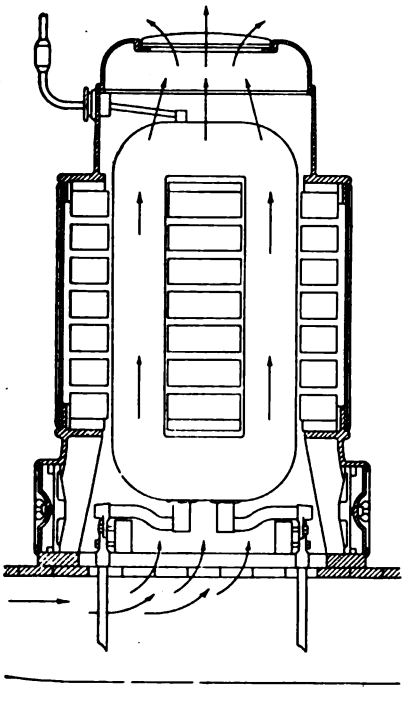
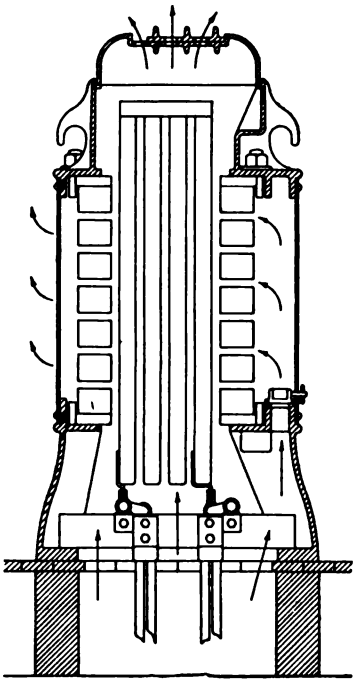
The Electrical Age.

VOL. XXII—NO. 2 NEW YORK, JULY 9, 1898 WHOLE NO. 582





Air Circulating in Air Blast Transformers.

Natural Draft Transformers.

COOLING LARGE TRANSFORMERS BY AIR BLAST AND NATURAL DRAFT.

To dissipate the heat generated in the cores and coils of transformers of large capacity offers considerably greater difficulty to the designing engineer than is the case with small transformers in which any design, consistent with reasonable efficiency, gives sufficient external surface to allow heat generated to radiate and so prevent undue rise in the temperature. With large transformers, however, the heat generated in the interior has less opportunity to radiate, and to dissipate it effectively without sacrifice of proportion or efficiency requires most careful design.

To construct large transformers, say, of 100-kw. capacity or larger, placing dependence for low temperature entirely on external radiating surface, necessitates too great a departure for economical proportions, and various designs have therefore been adopted in which provision is made for the circulation of a cooling medium through the interior of the transformer. If ducts passing entirely through the body of the winding are provided, they must be comparatively narrow, or the size and cost of the transformer will be excessive and the efficiency low; the space wasted is too great. With narrow ducts oil is not a reliable cooling medium. Its circulation under the best conditions is sluggish, while the ducts tend to close gradually under two causes—the swelling of the insulating wrapper on the coils and the collection in the ducts of a deposit derived from the slow solution of the various liquid insulations employed when winding the coils. To overcome these drawbacks a new design was introduced in which the height of the laminated core is small compared with the external dimensions of the punchings. A large proportion of the copper is external to the core, and the exposed ends are so spread apart as to give wide openings between the coils for the access of the oil. This design insures a low temperature in the exposed part, and even a moderate average temperature (measured by increase in resistance), but the central portion often becomes dangerously hot without giving any direct evidence of the fact; and it is no less serious to have a high temperature in any part of the transformer than to have the entire winding at an unsafe temperature.

In large transformers the use of oil is undesirable for reasons other than its poor efficiency as a cooling medium. The General Electric Company introduced and adopted the system of air cooling for its large transformers. In air-cooled transformers currents of air pass constantly through numerous narrow ducts, and come into direct contact with the heated surfaces absorbing their heat. Low temperatures are secured without sacrifice of efficiency or increase of cost, and the insulation, being constantly in contact with the current of air, needs no additional protection to guard against deterioration.

Two methods are employed as standard practice by the General Electric Company in the construction of its large transformers. In the air blast type the current of cool air is forced upward through the core and windings. In the natural draft type the coils and iron are so proportioned and placed that large surfaces are exposed, and the temperature kept within safe limits by the natural circulation of the air.

The air blast type is designed for continuous operation, large output and high potential. In this type, the windings are subdivided into numerous independent coils, each separately and heavily insulated. With such subdivision the voltage generated in a single section is low even in transformers wound for a voltage of 15,000 to 20,000 volts, and the numerous air ducts between all the coils which this sub-division allows, in addition to the spaces in the iron lamination of the core, limits the rise in temperature to a few degrees only above that of the active cooling air current. The coils are wound with flat copper conductors, cemented together by an insulating compound before the exterior insulation is applied. The method of winding and insulating produces a strong coil, which will successfully resist any tendency of the conductors to vibrate. The primary and secondary coils are assembled in small intermixed groups with air spaces

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between coils, and between every adjacent primary and secondary section are solid insulating diaphragms, which completely encase the primary winding except at either end of the core, necessarily left open to allow the air to circulate freely. At the end, however, the diaphragms project far beyond the coils, so that a surface insulation of great extent is provided between the primary and secondary. An additional insulation casing is placed around the entire structure of assembled primary and secondary coils, and separates the whole winding from the iron punchings assembled within and around them.

The cooling current of air is obtained from a motor-driven blower, and is forced from below through separate paths at right angles to each other, vertically through the windings and horizontally through the core. The admission of air is controlled by shutters at the top and at the side of the transformer. The power for the blower seldom exceeds one-quarter of 1 per cent of the total capacity of the transformer, and in most cases is much less, frequently not more than one-tenth of 1 per cent. It is considerably less than that which would be required to pump oil through an oil-cooled transformer of the same capacity.

Air blast transformers are used on 15,000 volts potential or under, and are constructed for higher potential when necessary. The efficiency under full load and partial load, determined under commercial operation conditions, is said to be extremely high. The regulation on both inductive and non-inductive loads, similarly determined, is remarkably close—an important essential when incandescent lamps and motors are operated from the same transformer. Over 100,000 horse-power in these air blast transformers has been installed, and no record yet exists of a burn out due to heating or overload.

In the natural draft transformers the dissipation of the heat is obtained by a natural circulation of the air around the coils. The core is formed of two upright legs on which the coils are wound. These are joined together by two yokes, which complete the magnetic circuit. The transformer proper is surrounded by a corrugated iron case, and rests on a substantial base of cast iron. The cool air enters from below and in passing through the transformer absorbs the heat and ascends, finding easy egress through the hood at the top.

Natural draft transformers are built in sizes ranging from 5 to 200 kilowatts. They require no attention, no blower outfit and may be located in any convenient place. The standard pressure for which these transformers are wound is 10,000 volts primary and 3120 volts or under, secondary. Transformers of higher primary voltage are built to fulfil special requirements.

WIRELESS TELEGRAPHY IN WALES.

The inventions of Herz and Marconi, respectively, have commanded much attention within recent years, and there has been a general feeling prevailing in this country that the experiments being conducted under the auspices of the Postal Department would result in the early establishment of telegraphic communication between distant points unconnected by wire.

It was reported in the press last year that Signor Marconi was personally experimenting within the limits of the port of Cardiff; that he had succeeded in demonstrating the practicability of his invention; and that Mr. W. H. Preece, the engineer-in-chief to the general post-office, was quite satisfied with the result. Mr. Preece has, in fact, long since had a system of wireless telegraphy at work at St. Martin's Le Grand, London, in connection with the general post-office buildings; but the intervening space has been necessarily limited, although intervening bricks and mortar have no effect upon the communication.

Mr. Preece has personally spent a great deal of his time intermittently upon the experiments in this locality. It seems that a cable was laid across from Lavernock Point, near Barry Dock, to Flat Holm Island, in the Bristol Channel, at an enormous amount of labor and expense, only to find that all had been wasted, because so many vessels drop anchor in these waters that the cable was dragged about and broken within one week from the time it was laid. Consequently, Mr. Preece set himself the task of experimenting with "wireless telegraphy," and under the direction of Mr. J. Gavey, his chief assistant, no effort has been spared in determining upon the best practical method of applying it. With 3¾ miles of water space between the points, no better place could be found for practically testing the new system; and, now that the desired communication has been established, the attention of the whole scientific world will be directed to it, and Mr. Preece will doubtless be invited soon to describe his experiments and their results.

The invention of Marconi has become familiar to, although perhaps not fully understood by, the lay mind, the theory having long since been made public property, and it being generally supposed that the system associated with the name of this young inventor would be adopted. But it transpires that Mr. Preece has perfected a system of his own, and has arrived at a satisfactory solution of this great scientific problem of telegraphing through a space of no less than 3¾ miles. It should be mentioned that as far back as 1892 the results obtainable were such as to justify the expectation of the desired end, but the various methods tried have all been more or less affected by disturbing influences. The system arrived at may be described as electro-magnetic, and is claimed to be free from such disturbances. The introduction of a very large copper wire and the alteration of the instruments, so as to embody certain desiderata, have been made; and it is stated that no less than forty words per minute have been transmitted without any necessity having arisen for obtaining a single repetition. If this report be true (and there appears to be ample confirmation that it is so), the most sanguine expectations of persons interested in this latest scientific wonder have been fully realized.

The following brief description appeared in a local newspaper on March 29:

"Copper wires of a very large gauge have been erected parallel with each other, one on the sea front at Lavernock Point and one across the Flat Holm, near the lighthouse—3 miles apart—and the Morse code signals transmitted are very distinct. Many improvements in the apparatus have been introduced since the previous trials were carried out, and it is very satisfactory to know that a high speed of working has been attained. The vibrations transmitted through space from the electric motor produce on the telephone receiver a most pleasing tone, and the combination of dots and dashes is easily readable by a manipulator. As many as forty words a minute have been signalled across and read without any difficulty whatever. There can be no doubt that the system of communication now permanently established between the fort on the mainland to the fort on the Flat Holm will mark an important epoch in the telegraphic developments of the century, and Mr. W. H. Preece is to be congratulated on the great success his method has attained. The two methods of so-called wireless telegraphy, which have recently created such widespread interest, were fully explained to a Cardiff audience at Mr. Gavey's recent lecture before the Cardiff Naturalists' Society. The post-office has considered it wise, for various reasons, to establish the permanent communication between Lavernock and the Flat Holm by means of the electro-magnetic rather than by Marconi's system, and, without entering into technical details or criticising the action of the Department in this matter, we can merely say that a thoroughly satisfactory and trustworthy telegraph service is now established between these two points, which, there

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is every reason to believe, will be free from the disturbing influences to which other methods are subject."

From other sources, I gather that on the mainland a stout copper wire has been fixed, as ordinarily, to poles, the length of the wire being three-fourths of a mile. The ends of this wire run into the sea. On the island a similar wire runs exactly parallel, as previously mentioned, to that on the mainland; and the length of the island wire is about half a mile, with the ends run to earth. It seems that the length of the parallel wires is governed by the extent of the space between them. The transmitting and receiving apparatus are duplicated, and it is said that the system is less costly than that of Marconi; that the parts of the apparatus are not so delicate; and that the necessity of having the instruments practically tuned to a nicety does not enter into its efficiency. The theory of electro-magnetic waves—that when wire A is charged with the current, so is its "field;" and that the circles of waves enlarge until they meet a conductor in wire B, which becomes charged to a certain extent—suggested to Mr. Preece the idea of his method; and the dots and dashes of the Morse system of telegraphy made it possible, the dot requiring a connection of shorter duration than the dash; and, as is well known, the arrangement of dots and dashes forms any letter or combination of letters desired.

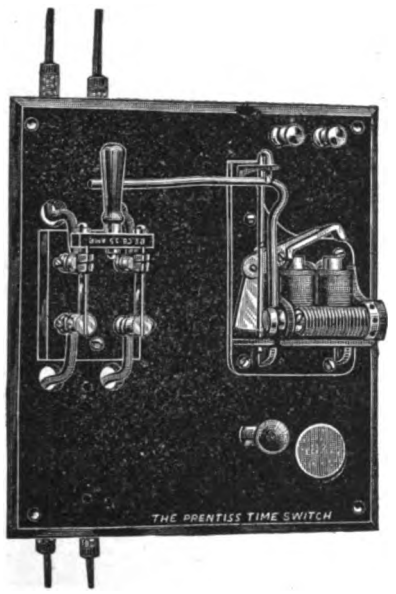
Ingenious mechanism is attached, by which a clear, musical note—C has been chosen as the best for hearing—is created. By means of a brass circle, in which there is an indentation at every three-eighths of an inch, the current is automatically interrupted at the rate of 250 makes and breaks per second, and when the dots and dashes are made by the operator at one end they may be heard at the other through an ordinary telephone. A great difference between this system and Marconi's is that the messages are read by sound, while in the young Italian scientist's they are recorded. This, I need hardly say, is of no importance; but if it be true that in Preece's system the transmission is no less than four times as speedy, the advantage is greatly in its favor. I may add that, instead of the ordinary "sounder," a telephone arrangement is brought into requisition, and the interpretation of the vibratory signals is said to be quite easy.

Now that a permanent system of wireless telegraphy for communication through space has been established, a new impetus will doubtless be given to further scientific researches in that direction. It is said that what led Mr. Preece to utilizing electro-magnetic induction was having it brought to his notice officially that, while messages were being transmitted over the post-office telegraph wires in Gray's Inn road, London, sounds could be picked up from the neighboring telephone wires. Thus, his mind was directed to the possibilities of the subject, it being obvious that the influencing of one wire by the current sent through another was inductive. This happened many years ago; but this famous electrician has been patiently experimenting ever since, until at last success has crowned his efforts. The hope of electricians to bring about telegraphic communication between vessels at sea and distant shores seems about to be realized, and soon the "transmitter" and "receiver" will be deemed essential on board every kind of craft sailing on the highways of commerce.

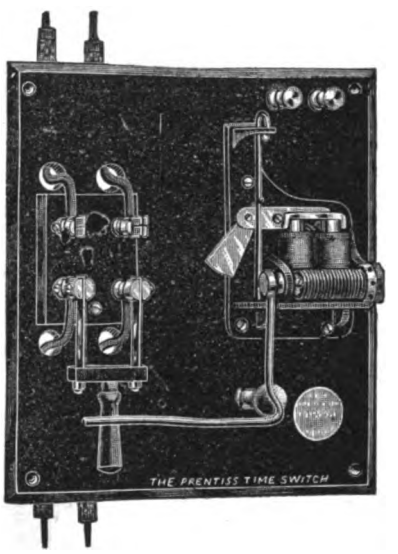
DANIEL T. PHILLIPS,
Consul at Cardiff.

THE MEASUREMENT OF TIME.

The demand for well constructed clocks of moderate price, which will keep good time without too much attention, is constantly increasing. The business of the Prentiss Clock Improvement Co. of 49 Dey street, New York, its improvement in clocks, and the growing favor with which their long-running clocks and automatic perpetual calendars are being received lead them to believe that the line which they are following is the right one and that there is abundance of room for these improvements. The effect of Time-Service Systems and Companies, especially in the larger cities, has been to lead the people to demand a higher grade of time-keeping and in consequence a better grade of clocks is required today, by most business concerns, than would have satisfied them some years ago. The importance of time as a factor in business success is becoming more and more apparent and there is every reason to believe that the clocks of 1997 will be better clocks than those of today. However this may be, the Prentiss Clock Improvement Co. believe they are equal to the present demand and that their sixty and ninety-day clocks are the best clocks which have ever been placed on the market when both price and grade are taken into consideration. Their automatic calendar still stands without a single competitor and is pronounced by customers abroad as well as by those in this country the most complete and perfect mechanism of its kind ever yet produced. It only has to be used to be thoroughly appreciated. As it does all that could possibly be required of a date-changing and displaying mechanism there is little room for improvement except perhaps in the direction of the cost of production, which of course depends largely upon the number used. The Prentiss Clock Improvement Co. have also made great improvements in synchronizing and electrical controlling devices,



The Prentiss Time Switch.



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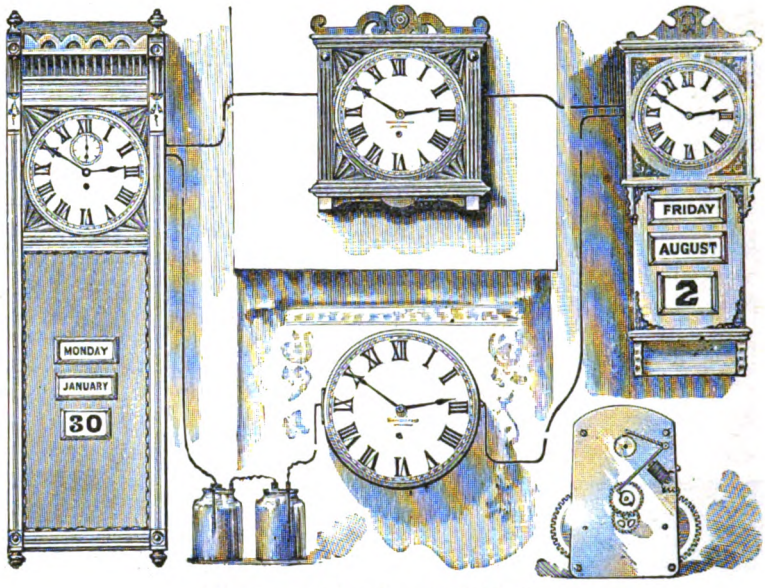
for producing uniform time, or regulating any number of clocks from a single Master Clock. Though not as well known as their calendar and long-running clocks, it is fast making its way as the most satisfactory and reliable Time-System in use today. It is both simple and low in cost especially in cost of maintenance.

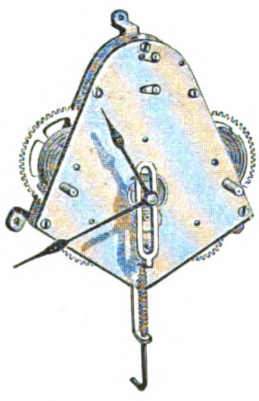
The sixty-day movement sold by the Prentiss Clock Improvement Company was used for many years in the time-service of the Prentiss Calendar and Time Company. Its aid had been so great and its reputation so general that those desiring the very best clock movement made have immediately procured the sixty-day movement. It possesses two springs; the winding is performed with a small crank-key and requires attention but six times a year; it is fitted with a dead-beat escapement. The qualities of this movement and the framework in which it is held are durability and reliability for long runs. The calendar movement is a distinct piece of mechanism. By pulling a cord or touching an electric button it is operated immediately. The date is automatically recorded, the apparatus being rewound but once a year.

The calendar is perpetual and consequently cannot be criticised for its duration of action. The synchronized clocks of the Prentiss Clock Improvement Co. are connected in series as shown in sketch. The clock movement in the right-hand lower corner shows a synchronizer attached to it. The large clock on the left is the regulator and master-clock. When a sub-clock is correct and needs no synchronizing it will be seen that the passing of the cam from the high part to the low portion, and the conseqeunt releasing of the lever which permits the armature to act, is simultaneous with the opening of the circuit by the master-clock, and that therefore no effect is produced.



A System of Synchronized Clocks.

A complete description of a synchronized plant of time keepers may be obtained from the catalogue of the above company. Several other types of clocks are mentioned, manufactured and sold, thousands of which are in use all over the United States and European countries. The time-switch manufactured by the Prentiss Clock Improvement Company represents an automatic device for turning off incandescent lamps at any appointed time. A single cell of dry battery will operate the switch, provided the clock is in the near vicinity by whose means the switch is indirectly operated. The switch does not arc but acts instantaneously. It is fireproof and finely



Prentiss Sixty-Day Movement.

Independent Empire Calendar

Calendar Movement.

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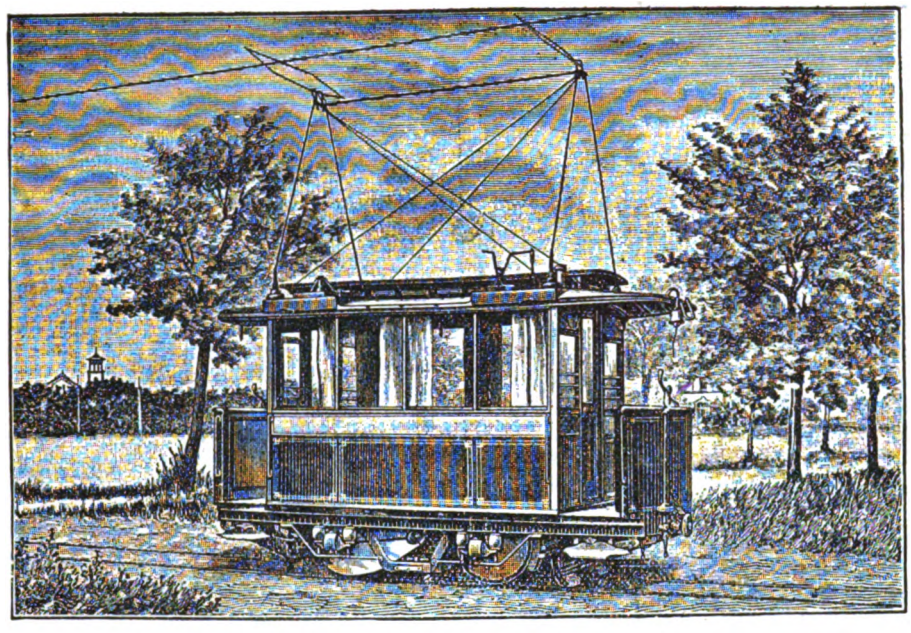
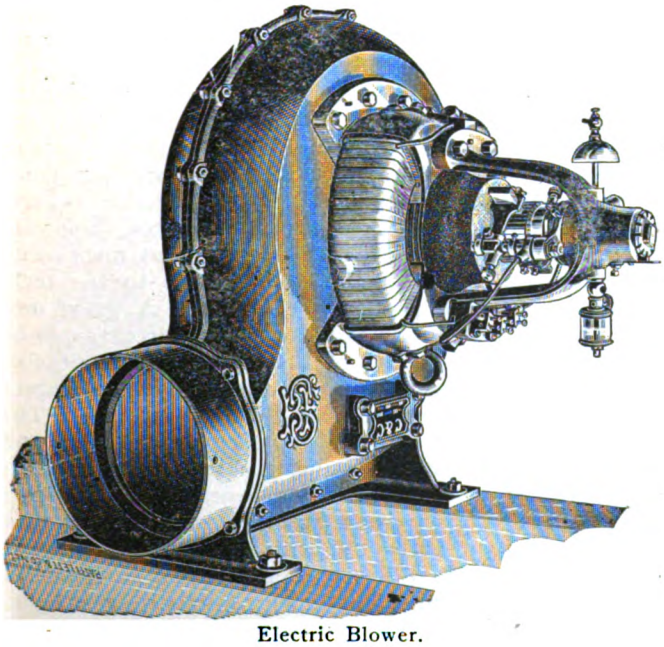
finished, and has met with wide application. For store and window lights, buildings and public institutions, the time-switch has been approved by the Fire Department and underwriters of New York City.

The above company have recently secured the contract for the Newark High School, in which a full system of clocks, including one master-clock, one programme clock with ten circuits, each circuit operating bells in different rooms, etc., is being installed. In addition a telephone system, connecting principal with teachers, greatly adds to the convenience of the pedagogues. An identical system is now being shipped to the High School at Springfield, Mass., with the exception of the telephone.



Early Style of Trolley Car.



Electric Blower.

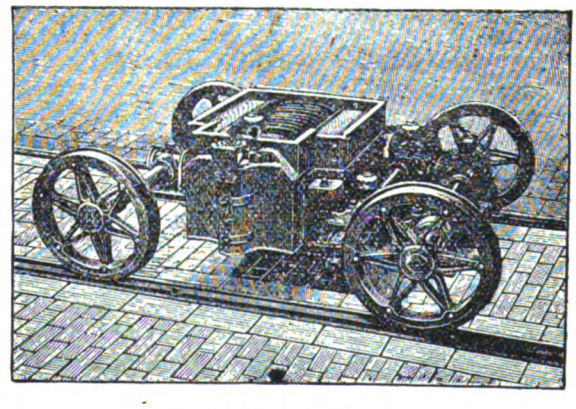
ELECTRIC MOTORS AND THEIR APPLICATIONS.

(Continued.)

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

A motor to satisfy the demands of modern design must fulfil certain functions. In earlier days Page made a motor which depended upon the suction or attraction of a helix for a soft iron core. The entire mechanism otherwise represented the details of a steam-engine. The slide-valve was duplicated by means of a contact-piece. Although the apparatus rotated, producing power and motion, it was not efficient, or at present more than historically interesting. From the first experiment of Œrsted sprang a host of inventions. Jacobi, working under the patronage of the Czar of Russia, built a small boat run by a motor which was used on the river Neva. In Germany many machines were produced that clearly showed the easy transformation of electric into mechanical energy.



Early Electric Truck.

In America, Froment and others set to work constructing small motors for practical purposes. A motor is today the most efficient machine in existence. Its principle of action is not less interesting than singular. In one respect it departs from the regular beaten path in utilizing power in a unique manner. Stripping the machine of all elaborations, it is to be seen that the attraction and repulsion of magnetic poles causes the rotation. It is necessary to have in every motor a source of magnetic power. No matter how rude the construction, this is an essential part of the device.

A bar of iron may be rotated in front of this magnet, attracted to a certain point, and then by means of its own momentum allowed to swing around and present its other end for attraction. In so simple a contrivance we have the elements of a modern motor. To enable the current to act in order that the magnetizing effect is auto-

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matically supplied when needed, a commutator is used. A switch which controls the current, acting by means of rotation, is the addition required. In large motors the field is kept constant. When the motor is started the field is the first part energized. The necessity for this will be explained later on. When the field is ready, rotation of the armature ensues as soon as current is let into it. The armature consists of a cylindrical body of iron upon which is wound coils of wire. These coils are connected to a commutator so that they are each individually attracted in rotating through the field. The armature is nothing more nor less than a compact form of magnet with innumerable poles.

If the armature rotates in a magnetic field, it does so because each of these coils individually are attracted by the current; this is effected by having a series of metallic strips composing the commutator connected to the ends of each coil. When these coils are made magnetic they move towards the nearest oppositely magnetized pole piece and rotation at once ensues.

This process is regularly occurring with every coil, and results in a rapid and even spinning of the armature.

In considering the dynamo it was observed that the conductors cutting lines of force generated an electromotive force. In a motor we also have conductors cutting lines of force; therefore an electromotive force is likewise produced.

It is necessary to appreciate this fact in order to understand the scientific meaning and bearing of the term efficiency. If the electromotive force generated in a motor while rotating were by any possibility equal to that supplied the motor would stop. There is always a difference between them, however, which depends upon the load of the motor.

If 100 volts were applied to the motor it might generate within its armature 90 volts; therefore only 10 volts can be effective in forcing current through it. The resistance of the armature must be low enough to allow sufficient current to pass at 10 volts' pressure to do the work required. This adjustment is constantly occurring between the load on the motor and the pressure generated within it. In this respect a motor is perfectly automatic and requires but little outside aid in certain types to overcome many difficulties hampering the speed.

The pressure created in the motor by its armature rotation is called counter or back E. M. F. The ratio existing between the counter and applied E. M. F. is a measure of the electrical efficiency of the motor.

$$\frac{\text{Back E. M. F.}}{\text{Applied E. M. F.}} = \text{Electrical Efficiency.}$$

The more rapidly a motor speeds up the greater becomes the counter E. M. F. with a constant field. The back E. M. F. becomes more and more identified with the applied E. M. F.

The armature takes less and less current, and in electrical efficiency the motor approaches its ideal value.

The commercial efficiency is the ratio existing between the power obtained from the motor and the power applied. A motor cannot have a high commercial efficiency with a low electrical efficiency.

$$\text{Commercial efficiency} = \frac{\text{Power received}}{\text{Power applied.}}$$

Each watt entering the motor equals 44.2 ft. lbs. The power applied can therefore be calculated. The power received from the pulley of the motor is obtained by means of a brake. It also represents foot pounds. In large motors this may be equal to 90 per cent.; the electrical efficiency may equal 95 per cent. in the same machine. To test a motor its load is entirely applied and the volts and amperes it consumes measured. The speed of the motor is taken and the pull in pounds measured on the periphery of the pulley. If the following data be considered the process will not be confusing.

Test of a motor. volts, 100
amperes, 10,
speed, 2,000
pull, 5 lbs.
pulley = 1 ft. diam.

Power entering = $10 \times 100 = 1{,}000$ watts.
$= 44{,}200.0$ ft lbs.

$$\text{Power received} = \frac{\text{Circumference of pulley} \times \text{speed} \times \text{pull}}{33{,}000}$$

$$= \frac{3 \text{ ft.} \times 2{,}000 \times 5}{33{,}000} = \frac{30{,}000}{33{,}000}$$

$$= \frac{9}{10} \text{ H. P.}$$

The commercial efficiency therefore is quickly found.

$$\frac{\text{Power received}}{\text{Power applied}} = \frac{9 \text{ H. P.}}{10 \text{ H. P.}} = 90 \text{ per cent.}$$

QUESTIONS FOR REVIEW.

(1) What causes rotation in a motor?
(2) What is back E. M. F.?
(3) State the conditions of highest electrical efficiency.
(4) Upon what does commercial efficiency depend?
(5) How is the commercial efficiency of a motor calculated?

MAGNETS AND ELECTRIC CURRENTS.

A most complete volume treating of the principles and applications of electricity has been published by Spon & Chamberlain. It is written by J. A. Fleming, M. A., D. Sc., F. R. S., who has already distinguished himself by a volume entitled, the "Alternate Current Transformer," a work much quoted in technical circles. The value of this later volume is highly evident from a general survey of its reading pages. The subject of magnetism in all its phases is carefully considered and considerable space is devoted to the subject of electrical measurements and the definition of units. Under the head of electromagetic induction, which is certainly a most important department of electrical engineering, a great mass of information is presented of the highest value to the technical student and practical engineer. A great deal of original matter relating to alternating currents may be found in the latter portion of the book and considerable information of a most practical nature is given in chapter X, entitled, "The Generation of Electric Currents." The book is a pleasure to read and represents much labor and care on the part of Mr. Fleming to obtain the proper arrangement of each subject and a presentation of principles that are backed up by useful and interesting matter of a character that will withstand criticism. To those already acquainted with the different departments of electrical engineering this volume will appear in its strongest light. To others just entering into a study of the science it will prove a valuable helpmate and ready reference.

Peterboro, Ont.—Mr. D. A. Starr, manager of the Cornwall Electric Railway Company, submitted to the town council at its last meeting a scheme for the construction of an electric railway from here to Chemong and Lakefield. The Company propose to lease the Chemong and Lakefield lines from the G. T. R., convert them into electric roads, and take over the freight business. The cost is roughly estimated at $350,000.

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COPPER MINES IN THE PHILIPPINES.

The present war has brought to the attention of Americans the fact that in Cuba and the Philippines great beds of mineral deposits may be found whose extent and value can scarcely be estimated. Spanish rule has never possessed those qualities which lead settlers to investigate and probe the earth for mineral wealth. The islands of the Philippines, especially, have been regarded more as vast tropical growths than as the possible centre of great mining industries, of large manufacturing concerns, and the site of great plantations. To the electrical profession the Philippine Islands are particularly interesting, because it is very likely that the protectorship exercised over them by the United States will be of such a nature as to lead to the development of her mining industries, which will be of large extent.

Mr. Frank Karuth, F. R. G. S., president of the Philippines Mineral Syndicate, Limited, in a letter to Ambassador Hay, states as follows:

"Copper is found in many parts of the Philippines and cupreous pyrites are not unfrequently met with, accompanying quartz veins, but in such small quantities as to exclude all commercial value. In the central mountain ranges of Luzon, however, between Cagayan and Ilocos, considerable deposits of copper are distributed and have been worked by a tribe of natives called Igorrotes, long before the advent of the Spaniards. They obtained the ore in excavations which they made with the aid of wood pliers, thus softening the rock. They separate the ore according to quality and roast the poorer repeatedly before smelting it. Their furnace is a cylindrical hole walled with clay, about twelve inches deep and eight inches in diameter, and they use blowers of bamboo worked with plungers to produce the requisite draft. A Spanish company was established to work these deposits on a large scale. Furnaces were built, machinery was put up, but what the natives could accomplish the European metallurgists failed to do, although in those days copper was worth over $500.00 per ton. The absence of roads told, and the enterprise eventually collapsed."

By these remarks our electrical friends can very readily judge of the latent possibilities, from the mining standpoint, of these islands. They seem to possess in an ideal manner all the requirements for the establishment of great electrical enterprises. Coal is to be found in abundance of the lignite order, plenty good enough for smelting copper or running electric light plants. The Philippines Mining Syndicate are now using this lignite for the operation of their steam engines. The coal is rich in carbon and burns well. It seems very likely that in the near future many manufacturing electricians will have good cause to visit Manila for the establishment of trading centres for purposes of manufacture. There are great gold fields on these islands, and from superficial investigation there seems to be plenty of other minerals to be found.

The Philippines of ten years hence will be so different from what they are now, with the addition of new blood and Yankee enterprise, that there will be not as great a contrast between the days of '76 and the close of this century as between Manila that was and Manila that will be.

DR. G. S. OHM.

When a great natural law is discovered it is as the result of careful thought and prolonged observation. It has never been the result of accident and has never been given voice to on the spur of the moment. There are only a few great laws underlying the framework of modern science, and from these laws have sprung various ramifications which lead to a-thousand-and-one channels of investigation. It requires a keen instinct and those powers of observation which only occasionally appear in men in order that they may follow out some great law or trace through a series of phenomena the influence of some predominant principle. It is somewhat surprising to realize the modesty possessed by those who have immortalized themselves in fields of science, art and literature.

Dr. G. S. Ohm, in his preface to the little book containing the discovery and interpretation of the great law bearing his name, states as follows: "I herewith present to the public a theory of galvanic electricity as a special part of the electrical science in general and shall successively as time, inclination and means permit, arrange more such portions together into a whole, if this first essay shall in some degree repay the sacrifices it has cost me. The circumstances in which I have hitherto been placed have not been adapted either to encourage me in the pursuit of novelties or to enable me to become acquainted with works relating to the same department of literature throughout its whole extent. I have therefore chosen for my first attempt a portion in which I have the least to apprehend competition. May the well-disposed reader receive the performance with the same love for the object as that with which it is set forth."

Dr. Ohm seems to have half believed that his invaluable treatise might not be well received by his confreres. We can best judge of that at the present day and marvel at his wonderful simplicity in offering his great work diffidently to the scientific world.

WALTER K. FREEMAN, the electrician, who was tried and convicted before Justice Smyth and sentenced to Sing Sing prison for seven years, was discharged from custody June 29th by order of the Court of Appeals. At the time of his trial he alleged that the case against him was the result of a conspiracy formed by a business rival. —N. Y. "World."

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ELECTRIC RAILWAYS.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

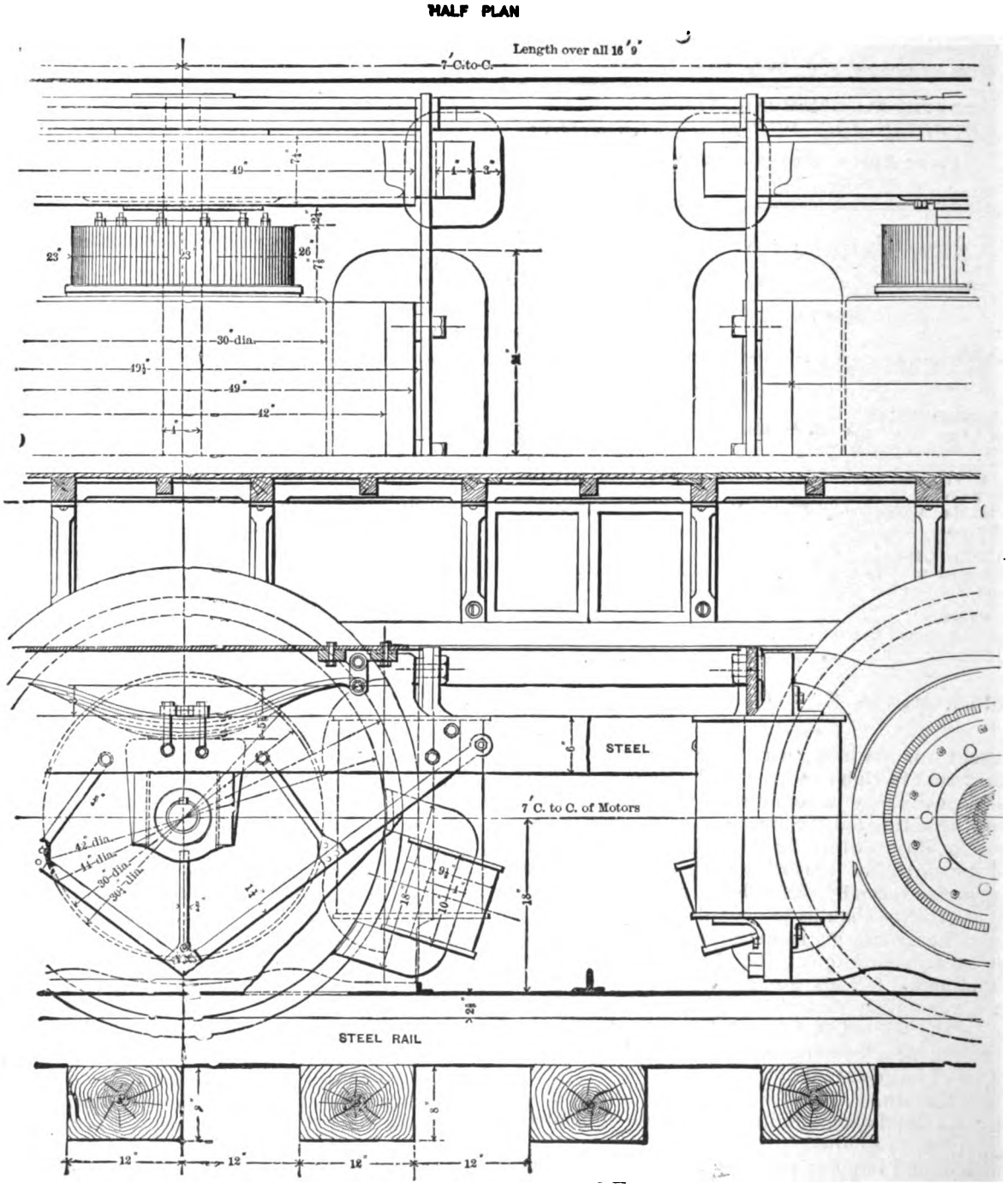
BY NEWTON HARRISON, E.E.

Many systems of railroading have been attempted in this country. The labors and extensive experiments of Siemens in Germany, Edison, Daft and Sprague of America, were not always crowned with success. The difficulties that beset the path of the inventors, the poorness in one sense of the mechanism, and the difficulty of obtaining the proper materials, greatly prevented them from progressing with any rapidity. The result of their efforts has been, as we well know, very successful from a practical standpoint. The electric railway of to-day is but part of a vast system that will replace all else and whose lines will reach from the Atlantic to the Pacific. The systems of railroads that have been tried with more or less satisfaction are contained in the following list:

SYSTEMS:
The Trolley,
Conduit,
Block,
Storage battery.

STORAGE BATTERY CARS.

Several combinations of the above have occurred, such as a block-storage battery system of Johnson and Lundell. A method once suggested was that of having steam and dynamo plant on the train and feeding direct to the motor beneath. This was thought far superior in efficiency to the use of a steam locomotive, whose record of usefulness does not exceed four per cent. The diversity of opinions existing relative to the gain and excellence of different systems hardly exist at present. The storage-battery traction method would be first-class if the storage battery were not so heavy, less troublesome to handle and a little more efficient in delivery of power. The trial made with these cells and other hybrid types has been in this city, at least, without other than temporary success.



Plan of Electric Road; Speed 150 Miles an Hour.

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The trolley, conduit and block systems carry only the motor, but the storage-battery car moves along dragging at the same time a ton or more of cells. These cells do not pay any fare and necessitate extra contrivances for their hasty transfer from car to station or the converse. Many managers of bankrupt companies could supply eloquent testimony in relation to the subject.

CONDUIT.

Germany has enjoyed the privilege of having within its confines one of the few successful open conduit electric roads in the world. It had the first. The desire to emulate the example of German engineers caused several subscriptions in that direction which in this country last year signally failed. The development of a railroad scheme having a conduit road as its basis was looked upon as impossible. An open slot cable conduit differs in no particular from the cavity used for electrical purposes. Two conductors, insulated as carefully as possible and protected from the drippings that might corrode and injure them, are laid within side by side. A trolley wheel slide or equivalent arrangement takes current from the wire to the motor above.

As far as the running of the system is concerned, it has proven a success. The financial end is not open for public inspection. The travellers who employ the car from point to point express satisfaction, so that from a popular point of view the road is all right. The future of this road embraces that of many others. The trolley is dispensed with and the wholesome objections of municipal authorities to all external appliances. The leakage within the conduit may be brought to a minimum by having large, open and frequent sewer connections. The drainage is thus rapidly removed, and the only loss of power is that due to the moisture and condensation on the exposed wires and their supports.

Napanee, Ont.—The town council have accepted a proposition made by John R. Scott to supply electric light. Mr. Scott agrees to install an incandescent and arc plant within one year.

Bridgetown, N. S.—A company is being formed to supply electric light generated by water power. It is proposed to lay an iron pipe ⅝ of a mile in length. Curry, Bent & Co. are interested.

ELECTRIC TRACTION.

NOTES ON THE APPLICATION OF ELECTRIC MOTIVE POWER TO RAILWAY SERVICE, WITH ILLUSTRATIONS FROM THE PRACTICE OF THE METROPOLITAN ELEVATED ROAD OF CHICAGO.

BY M. H. GERRY, JR.

In the following paper will be found a brief discussion of some of the more important problems arising in connection with the application of electric motive power to the heavier classes of railway service. A number of tests and diagrams from the Metropolitan Elevated Railroad of Chicago are introduced by way of illustration.

A part of this paper relates especially to the application of electric power to passenger rapid transit on elevated and suburban roads. The conditions for this service differ somewhat from common railway practice. Regular stops are made at frequent intervals; the distance between stations on elevated roads, for example, averaging about 2,000 feet. The interval between trains is small, and the time of stops very short. The traffic is irregular, is heavy at certain hours, and is apt to increase and decrease at a rapid rate. To make the fast running time desired, the speed must increase up to the point where the brakes are applied; thus the maximum of speed is high compared with the mean speed. There is little or no opportunity for maintaining the speed, and the running time depends almost entirely upon the rate of accelerating and retarding of the train.

With a given number of stops per mile, the amount of power required will increase very rapidly with the speed beyond a certain point, and the cost per car mile will not furnish a reliable basis of comparison for the motive power of different roads unless the conditions are the same. A slight difference in the average speed, or in distance between stations, may cause a considerable change in the amount of power required.

There are in operation at the present time several noteworthy examples of the application of electric motive power to the heavier classes of railway service. The most important of these installations are the Lake Street and the Metropolitan Elevated Roads of Chicago, the Baltimore Tunnel Line of the Baltimore and Ohio, and the Nantasket and Berlin lines of the New York, New Haven and Hartford Railroad. From the experience gained on these roads, there is no longer a question in regard to the ability of properly designed electric motors to operate trains of the heaviest weights in service, and at any speed permissible under practical railroad conditions. In the future, matters of efficiency and general utility must determine the desirability of electric power for any particular railway service.

Certain operating conditions have a special bearing on the efficiency of this form of motive power; the most important being the frequency of the train service. If traffic is such that a large number of trains must be operated on a division, the electric power will have an advantage, in point of economy, over steam locomotives; and if the trains are few, the reverse will be the case. This condition holds good independently of the weight of the trains or of the speed attained. The length of the line is in itself no bar to the successful operation of an electric railway system, as, by using alternating current apparatus, the power stations may be located favorably, and at long distances apart.

The distribution of current to the trains, while it presents many practical difficulties in detail, is not so serious a problem as it was thought to be at one time. Of the three systems of over-head conductor, conduit, and third rail, the last has given the best results, and is advisable wherever the conditions are such that it can be installed. For roads operating on their own right of way, there is really no serious objection to the third rail, and all of the difficulties encountered at crossings, switches and in yards can be overcome by methods already in use on the roads named above, or by other devices that have been proposed. It is not to be expected that all details of such a system are in an entirely satisfactory and final form, but they are practically operative at present and being constantly improved as difficulties develop in service. The experience already gained also justifies the statement that a reliable overhead or conduit system for heavy service can be constructed if the conditions favor the use of such methods.

The Metropolitan Elevated Railroad.

This system, now in its second year of operation, is the largest road in existence employing exclusively electric power for a heavy passenger service.

The structure has four tracks, from Market street west to Marshfield avenue, at which point three double-track lines diverge. The northerly branch divides again near Robey street into two double-track branches. From Market street to each of the terminals the distance is about six miles. (See map, Fig. 1.)

Current is conveyed to the trains by the third rail system; the "trolley rail" being placed 20 1-8 inches outside and 6 1-4 inches above the running rail. It is of the common "T" section, bonded with leaf copper bonds, and divided into sections to provide for expansion. The in-

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sulation for the third rail, on all but a small section of the road, consists of hardwood blocks, mounted on small iron chairs fastened to the ties. On a recent extension an improved form of insulation made of stone-ware has been tried with success. The electric leakage is small at all times. In dry weather it is entirely negligible, and in wet weather is never more than a few amperes. It is greatest after a dry season, when the first shower is washing the accumulated iron dust from the insulating blocks. Steel rails are used for feeders, and copper only to make connections. The feeder system is divided into six sections, which are tied together at junction points through circuit breakers placed in the interlocking towers.

The rolling stock consists of motor cars, passenger cars and a few coal and flat cars. The motor cars measure 47 feet in length and weigh about 62,000 pounds when loaded to their maximum capacity. They are mounted on rigid bolster locomotive type trucks, having 33-inch steel tired wheels. The truck centres are 33 feet 6 inches apart and the truck wheel base 5 feet 6 inches. One truck of each motor car is equipped with two motors, each nominally rated at 2,000 pounds drawbar pull. The motors are operated by series parallel controllers, situated in the cabs at each end of the car. Rheostats of the packed ribbon type, used in connection with the controllers, are placed underneath the car. A circuit breaker placed in each cab is used both as a safety device and as a main switch for opening the circuit between the trolley device and the controller. A main fuse box is also provided and placed in one of the cabs as an additional safety device, but experience has shown that failures of the circuit breaker to act are so rare that the former piece of apparatus might well be omitted. Circuit breakers have proven very satisfactory for this service, as they cost little for maintenance, are reliable as safety devices, and by their quick action reduce to a minimum the damage to apparatus from grounding and short-circuiting.

The cars are warmed by electric heaters arranged in three circuits, two of which take about seven amperes each and the remaining circuit about four amperes. All of the heaters are required only in the coldest weather, and are turned on and off by the trainmen. By cutting out all or part of the heaters for a short time when the traffic is heaviest, the peak of the load can be reduced and the heaters used to improve the load factor.

The air brakes are of the direct or "straight" air type, with an additional re-enforce cylinder. The air is compressed to 60 pounds by a vertical pump, driven by a motor of about three horse power. The pump motors have automatic control, regulated by the air pressure, and also hand control from each end of the car. The pump, with its motor and automatic controller, is placed in one of the cabs.

The passenger cars are 47 feet in length and of the standard pattern in use on all elevated roads. They are mounted on swinging bolster trucks, having 30-inch wheels, and when loaded to maximum capacity weigh about 46,000 pounds. Two, three, and four car trains are in service at different hours, corresponding with the traffic. About 1,200 trains are handled daily and under very close headway out of Franklin street terminal.

The power house is supplied with water tube boilers, mechanical chain stokers, coal and ash handling machinery, forced draft, automatic oiling system, and all modern appliances. The boilers are fourteen in number and work at 165 pounds pressure. There are four vertical cross-compound engines, direct-connected to the electric generators. The condensing water is taken from the Chicago river by tunnel, and water for the boilers from the city mains. There are four electric generators, two of 1,500 kilowatt and two of 800 kilowatt capacity. The switchboard is placed on a gallery and is provided with the usual instruments, including recording wattmeters for each generator. There are six feeder panels corresponding to the divisions of the feeder system.

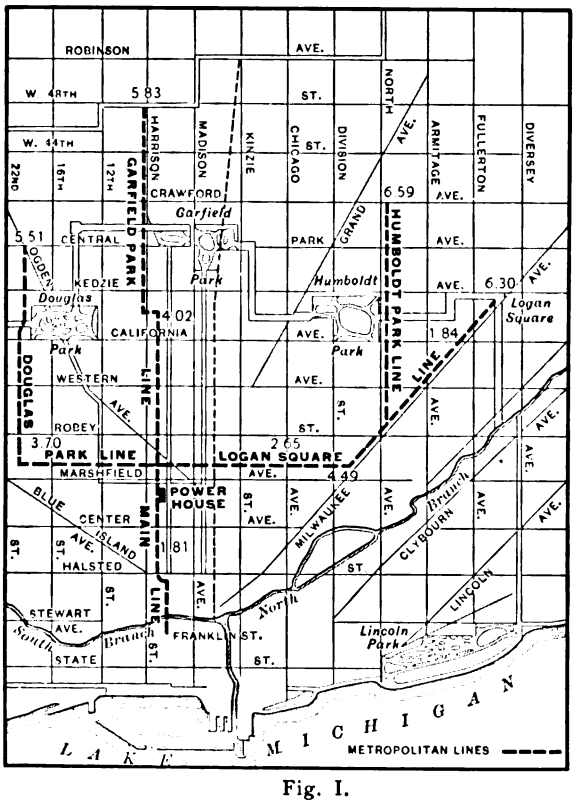

Fig. I.

The Power Absorbed by Trains.

In an electric railway system, the mechanical energy supplied at the engine shaft may be divided, for purposes of discussion, into two general classes. First, that finally absorbed or utilized in propelling the train, and, secondly, the energy lost in transformation and transmission, including losses in generators, line, rheostats and motors.

The first division or class, that is, the energy to propel a railway train, may be divided again into three parts:

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First, that required to overcome inertia and accelerate the train to its maximum speed after each stop. Secondly, the energy required on account of ascending grades. Thirdly, that required to overcome train resistance, including friction, air resistance, etc. If the stations are far apart, the energy required to accelerate the train may be neglected without serious error, but for a service where trains make frequent stops, and the maximum speed is high, compared with the mean speed, it becomes of importance, and may easily be the greatest of all losses. The amount of energy required for train acceleration obviously depends upon the number of stops, the train weight and the maximum speed. Knowing these quantities, it can be readily determined from the common mechanical formula for kinetic energy:

$$U = \frac{w\,v^2}{64.4}$$

The horizontal effort or drawbar pull required to produce a certain acceleration in a given time may be obtained from the mechanical formula, $f \frac{w\,v}{32.2\,t.}$

The work done in ascending grades is the product of the train weight and the vertical distance the train is lifted. The horizontal effort required to take a train up a grade is equal to the product of the train weight by the per cent. of grade.

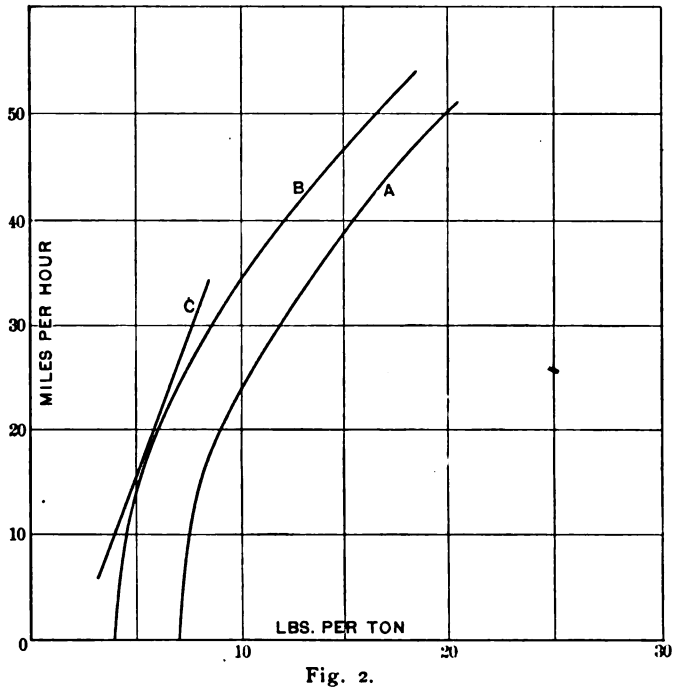

Fig. 2.

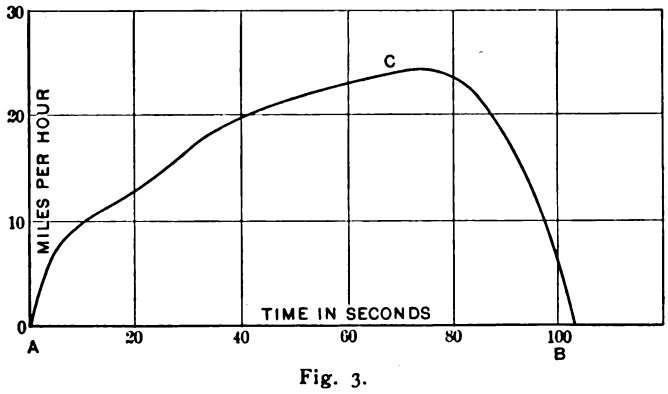

Fig. 3.

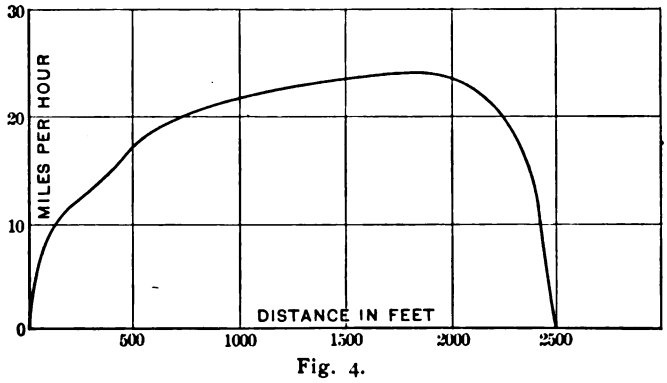

Fig. 4.

Train resistance, as used in this paper, includes all retarding forces other than those due to inertia and grades. Formulas for determining this quantity are empirical and are based upon experimental results, where the conditions have varied widely. D. K. Clark, in "Railway Machinery," recommends a formula which, reduced to

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tons, of 2,000 pounds, becomes $R = 7.1 + \frac{v^2}{192}$. Another formula in use is $R = 4 + \frac{v^2}{200}$, where R = resistance in pounds per ton of train weight, v = speed in miles per hour. These two formulas have been plotted in Fig. 2 and are marked respectively A and B. From measurements taken on the Metropolitan Elevated, the curve C has been determined and is used in the following discussions.

In Figs. 3 and 4 are shown actual speed curves on a time and a distance base for a train running between stations 2,500 feet apart. For the purpose of discussion, consider the train weight as 100 tons and in the first case assume it to be on an ascending grade of ½ of 1 per cent. From the curves, the speed at the time the brakes are applied is 24 miles per hour, and the kinetic energy at that speed, for the train, is 3,800,000 foot pounds. The time consumed up to the point where brakes are applied is 77 seconds, and the energy to overcome the 0.5 per cent. grade while the train is passing over the first 1,900 feet is equal to 1,900,000 foot pounds.

(To be continued.)

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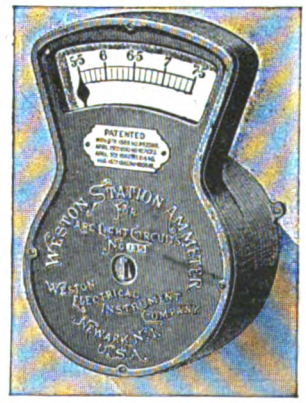
Secretary Long of the United States Navy had his attention called to a description of the New Standard Dry Battery, published in the "Electrical Age" last spring, and since then several thousand cells have been used by the Navy Department for exploding bombs and mines. At many points the cells are permanently connected with mines in harbors and channels to guard the cities bordering on the same against any hostile invasion. This dry battery has been carefully tested by the experts of the Navy Department and found to be greatly the superior in strength of test and long life. Mr. Roche manufactures batteries of all styles and sizes for all applications. They range in size from a battery no larger than your finger to one the size of a barrel, if you need it. The standard size is the bell battery.

New Standard Dry Battery.

It will be remembered that it was Mr. Roche who made the "Exeter" dry battery, which was selected out of several hundred different makes for use at the World's Fair at Chicago in 1893. It was used with the "Victor" key by President Cleveland to open the exposition. Mr. Roche manufactures dry batteries for the trade in general and will put on any trade mark requested by buyers. He is one of the broadest-minded men in the dry battery business, and his success has been mainly due to his liberal American ideas.

Henderson, Tex.—J. T. Wilkerson, of Pittsburg, Tex., has established a telephone system in Henderson, and will extend it to nearby towns soon.



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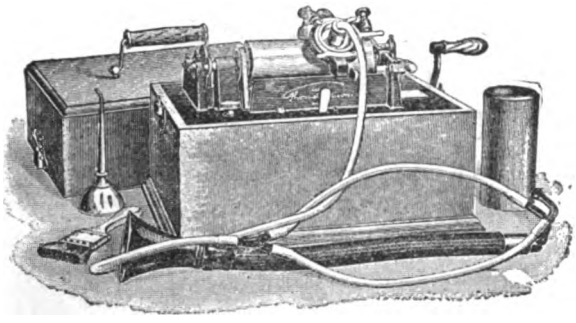
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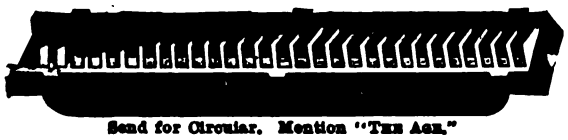
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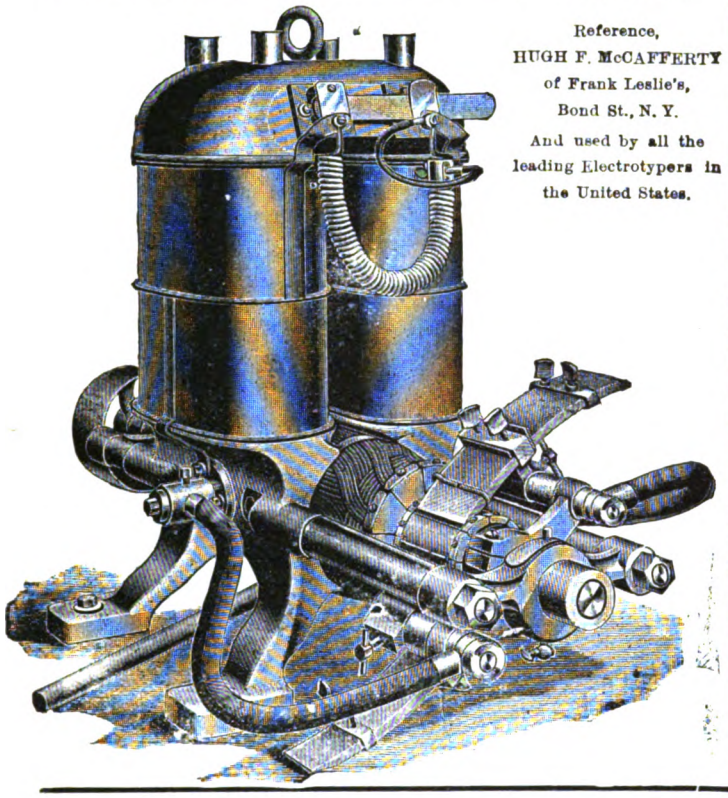

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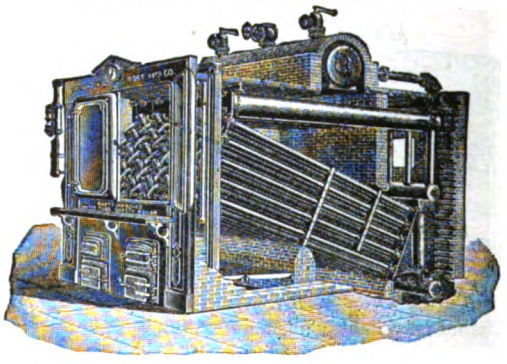

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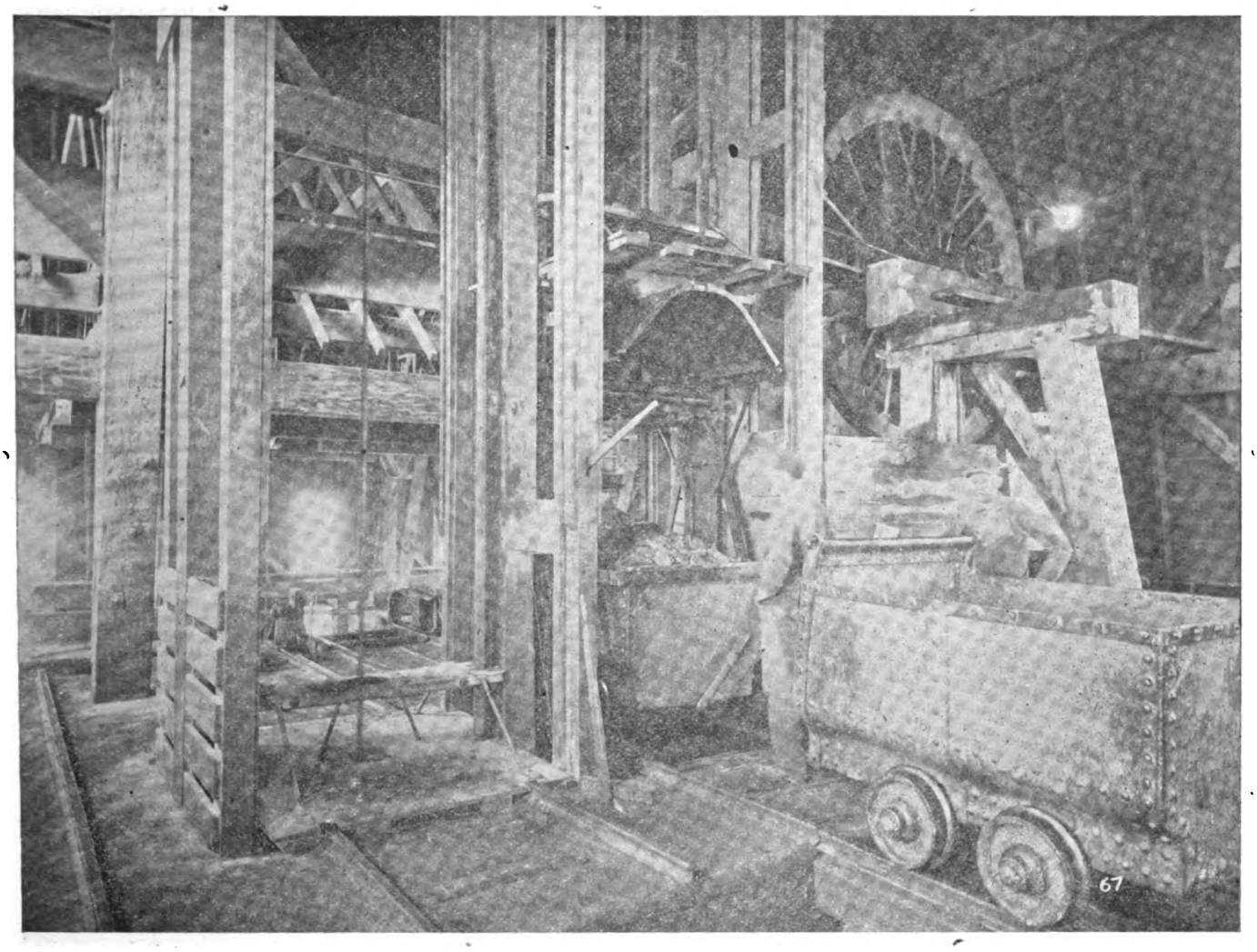

Tamarack Copper Mine, Michigan.—No. 2 Shaft House.

SOME NOTES ON A LAKE SUPERIOR COPPER MINE.*

The illustrations given herewith are from photographs taken above and underground in the Tamarack Copper Mine, in Michigan. The first view shows the interior of No. 2 shaft-house, with a car of rock on the cage. The usual time for raising the cage from the bottom of the shaft, 3,775 ft., is one minute. The second illustration shows the sixteenth level plat at the same shaft, with a mine car carrying three tons of rock ready to run on the cage. The third photograph shows tramming in one of the deep levels.

The Tamarack Mine has at present the distinction of having the deepest mining shafts in the world. There are five shafts, No. 1 being 2,240 ft. deep; No. 2, as just mentioned, 3,775 ft.; No. 3 is 4,526 ft.; No. 4 is 4,450 ft. deep, and No. 5, which is now down 2,450 ft., will be, when completed, nearly 5,000 ft. in depth. The company's property is immediately west and north of the Calumet & Hecla's, and it was forced to sink deep vertical shafts in order to penetrate the copper-bearing conglomerate in its downward dip of about 38 degrees. No. 3 shaft reached the lode at a vertical depth of 4,185 ft.; No. 4 found it at 4,393 ft. The first shaft sunk, No. 1, was further north than Nos. 3 and 4, and struck the conglomerate sought at a depth from surface of 2,270 ft.

There has been no sinking at No. 1 shaft for several years, it having reached the Calumet & Hecla line in its descent. It is 2,240 ft. deep. No. 2 shaft, 600 ft. north of No. 1, is at the 25th level. The lower seven levels have been opened up north and south of the shaft, but there has been but little stoping done. An important work has been begun here in the sinking of an incline shaft located between Nos. 1 and 2. East of the Calumet conglomerate about 100 ft. is a belt of amygdaloid having a thickness of 100 ft. It follows down under the conglomerate regularly, having the same dip, and Captain Parnall, the superintendent, has decided to sink a three-compartment shaft in it. Crosscuts have been driven to it from the 17th, 18th, 20th and 21st levels of the conglomerate belt. The ground is firm, and the shaft will be a substantial one. It will be carried down under the conglomerate and connect at the different levels with the latter. The vertical shafts as they go down are farther away from the lode at each additional level, necessitating very long crosscuts, about 1,500 ft. at the bottom of the mine in this territory. The dip of the lode is about 37 degrees, and takes the latter from the vertical shaft rapidly. Levels are about 80 ft. apart, vertically, and about 133 ft. on the incline. The cost of driving the long crosscuts is a heavy one, the tramming distance is too great, and then it takes time to connect the shaft with the lode. By following down in the amygdaloid belt referred to, the crosscuts will be short, all of the same length and all of the mineralized lode can be taken.

* Loaned through courtesy of Engineering and Mining Journal.

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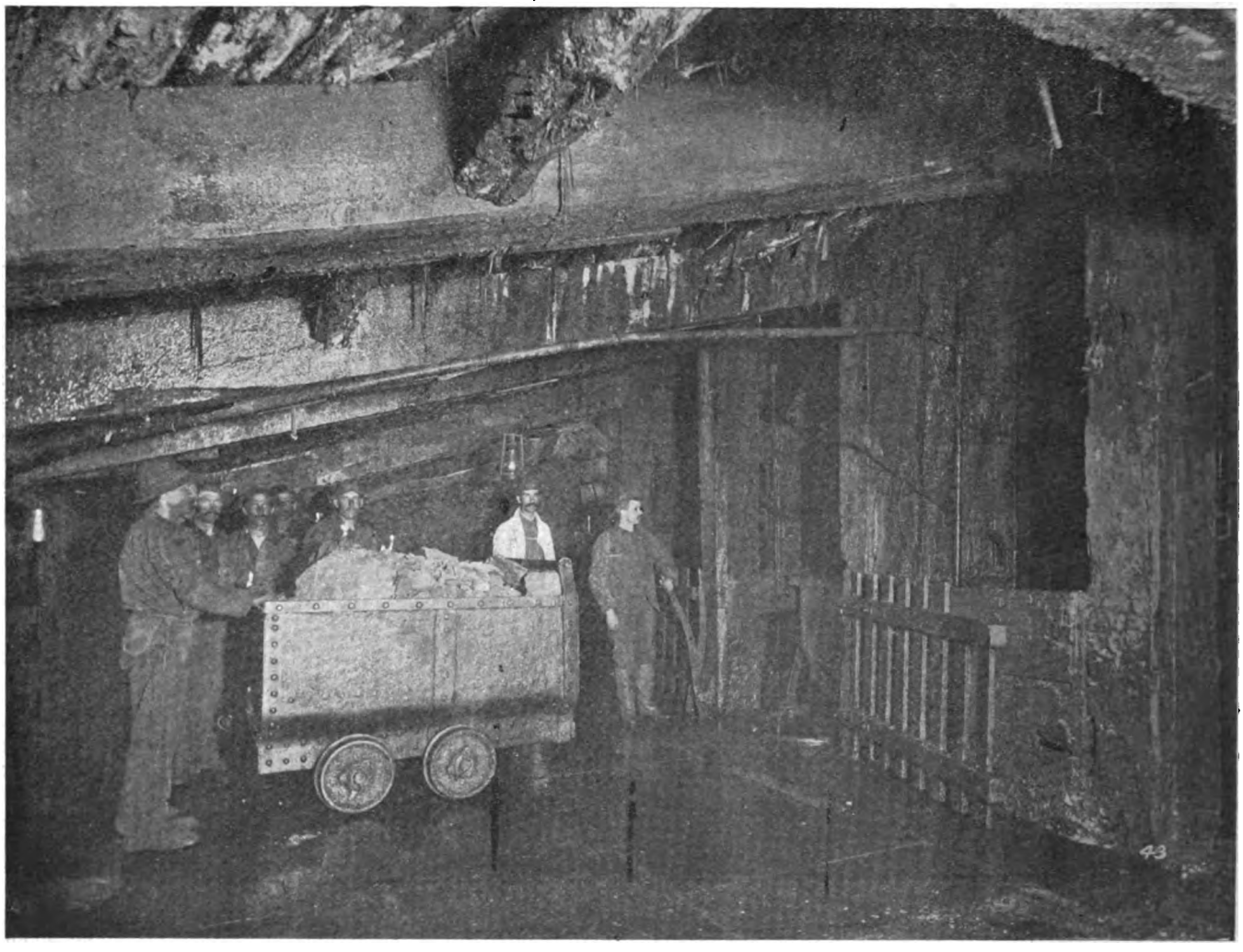
No. 3 shaft, 4,200 ft. north of No. 2, is now 4,526 ft. deep and 14 levels have been opened. The method of opening at No. 3 agrees with that being followed at the lower levels of No. 2. They carry their main drift and a cutting-out stope to the boundary of the property and then stope out the ground from the extreme ends of drifts to shafts, letting the hanging come down after the rock holding copper has been taken. The lode in this portion of the mine is very wide, running from 20 to 25 ft It is seldom all copper-bearing, and there is no regularity as to the coppery and barren places.

No. 4 shaft, 700 ft. north of No. 3, is 4,450 ft. deep. But little work has been done here the past year. No. 5 shaft is the one that is sinking for the lode and was started the latter part of the year 1895. It is located 3,300 ft. south of No. 4, is five-compartment, 27 ft. 5 in. by 7 ft. 2 in. There will be four cage-ways and a ladder and pipe way. It was sunk 1,029 ft. during 1897, which is excellent work. It is expected to strike the lode at a depth of 4,600 ft. The hoisting plant installed here will be of a type new to the Lake Superior country. There will be four engines, one at each corner of the great frame. They will be set in an inclined position, cylinders being 32 in. diameter and 56 in. stroke. The drum will be tapered at both ends, running from 16 ft. at end to the straight face of drum, which is 25 ft. diameter. It is claimed for this four-cylinder type engine that it will start the load readily and smoothly, and give the highest efficiency.

According to the report for 1897, there was hoisted from the mine a total of 726,665 tons of rock, of which 611,539 tons were stamped. This gave 29,580,380 lbs. of mineral, yielding 20,222,559 lbs. of ingot copper. The copper yield was 1.65 per cent. of the rock stamped. The total cost of working in 1897 was $2.07 per ton of rock stamped.

The new stamp mill of the company has seven heads, all with solid foundations and 20 in. cylinders. The daily performance per head for actual running time was 332.95 tons per day.



Tamarack Copper Mine, Michigan.—Plat on Sixteenth Level, No. 2 Shaft.

HOW BRITAIN HAS LOST THE ELECTRIC TRACTION TRADE.*

BY E. F. VESEY KNOX, M. P.*

During the past ten years the United States have, by the policy of "free streets," created an industry nearly as great as the trade which Great Britain has secured in China by forty years of "open ports."

During the last six years there have been built or equipped for electric traction 12,000 miles of street railroad or tramway in the American Republic. Some part of this vast total is suburban line, lightly and cheaply laid; other parts of it expensive conduit line, as in New York. It would, perhaps, be a fair average to take £5,000 per mile as the average cost of construction and equipment. This gives us the stupendous total of £60,000,000.

If Sir Robert Griffen is right in putting the total export of articles of British produce and manufacture to China at £10,000,000 a year, the American electric traction industry and our China trade stand practically on a level. But whereas the greater part of our China

* London "Invention." * In the "Daily Mail."

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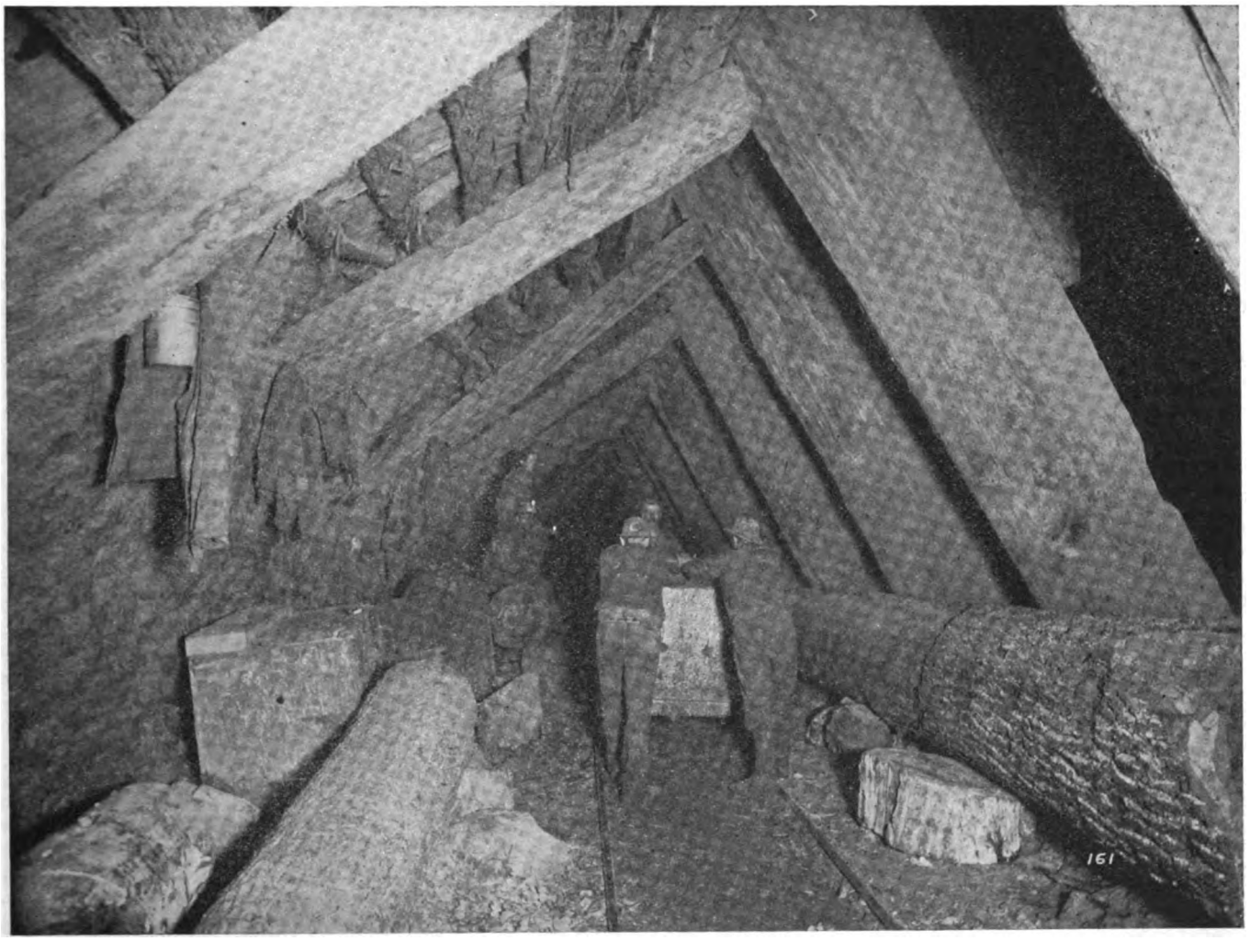
trade is in cheap commodities, where skilled labor bears but a small proportion to the total cost, the traction trade requires and develops the highest and most technical artisan skill, and is consequently of enormous social importance. It may be objected that the United States cannot go on making 2,000 miles of tram lines every year, and that the trade must, therefore, prove ephemeral. Even if there were to be no export trade, extensions and renewals in the States alone must continue to employ a vast army of workmen. But there is an export trade.

Whichever country gets the start in the new industry requiring technical skill is bound, other conditions being equal, to keep the start. England got the start in engine making and in cotton manufacture, and to enables American steel makers to turn out cheaper and better grooved rails.

Curiously enough, there is just one branch of electrical equipment in which England still holds the field—the manufacture of feeder cables.

England got the start in making cables for submarine telegraphy, and she still can make better cables for this and all cognate purposes. Thus even the exception proves the rule; in the handicap of commerce no nation can afford to give any other a long start.

Do not let anyone tell me that Englishmen prefer horse trams. I don't believe that anyone who has ever seen an electric tram prefers a horse tram. The fact is that on a good road paved with wood a horse tram has scarcely any economic justification. The advantage of the horse



Tamarack Copper Mine.—Tramming in a Lower Level.

that start most of her prosperity during this century is due.

America has got the start in electricity, which will be the motive power of the next century. The municipalities and state governments allowed electric tramways to be constructed on easy terms in every American city. American engineers were eager to supply the need. They have developed machine tools, manufactories, skilled labor. To-day they command the markets of the world in all that has to do with electric traction. The equipment for the Waterloo and City and the Central London lines is coming from America. Leeds, in the centre of the locomotive district, had to get its motor cars from America. The first Dublin contract was placed here, but American workmen had to be brought over to complete it. Now the whole electrical equipment for the new extensions has been ordered in America. Cork is even getting American tram rails, for the greater demand

tram over the 'bus is simply in the economy of tractive force produced by running with flanged wheels in a grooved rail. Estimates of the amount saved vary, but the difference is decreasing as roads and wheels improve, and is now comparatively insignificant. It never can be anything like the economy of running on a railway rail, for the dirt and wet which get into the groove must always be a serious set-off against the smoothness of the steel. The horse tram is as noisy as an omnibus, is no speedier, and takes up as much room in the road.

Nor can much be said for the steam trams, of which we still have a few. They are quicker than horses, but they are ugly, dirty, and even dangerous. But with the electric tram it is different. The essential principle of electric traction is that the force is produced not on the street, but in a central power station. Horses, steam engines, oil motors, all take up room and have the other disadvantages which are inevitable if we produce motive

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force in retail quantities in the streets. Modern invention has shown us how force can be produced in the factory and distributed to the cars. At the factory are big engines and big dynamos producing electricity on a wholesale scale, the noise and dirt confined to one small area of land away from the public eye.

There are various modes of distribution. There is, firstly, the accumulator system. Under the seats of the car are accumulators, which are charged with electricity at the station. We bottle our electricity, as one may almost say. Londoners are becoming accustomed to accumulators on electric launches and electric cabs. There is no reason except expense why accumulators should not also be used for omnibuses. In Birmingham, Ostend and many other places they are used for tramcars. But the cost is heavy. There is the loss of force, the heavy deadweight to be carried in the cars, and the frequent renewal of accumulators. If the accumulator system were more economical, electricians would not waste their energies in fighting local authorities for tramway concessions. They would put up with the disadvantages from the point of view of tractive force and use the wood pavements without payment, as the omnibus companies do.

The two practicable systems are the conduit and the overhead trolley. In both of these systems the power is conveyed along the line of route by a wire. On the conduit system the wire is carried underground in a concrete conduit and is reached through a slot either in a third rail or in one of the side rails, which must be extra broad. The conduit system involves no greater disfigurement of the road than does a cable tram, and is said to be efficient, but it is expensive, the cost per mile being estimated at as much as £15,000, and necessitates considerable interference with underground pipes, etc., as the concrete bed must be 18 in. to 2 ft. deep. It remains to be seen how far insulation can be obtained on the muddy London streets, and the cost of maintenance must always be considered. The pressure of wood pavement after rain is apt to close the slot, and Londoners would not like to be without their wood pavement. The overhead system is that more generally adopted in the States; it is the cheaper and more efficient.

Committees appointed by the corporations of Leeds, Belfast, Glasgow, Sheffield, Birkenhead, Liverpool, and Manchester have, after inquiry, all reported in favor of the overhead wires. As the Glasgow committee say, the overhead system is that which electricians would erect everywhere if they were allowed. The wire along which the electric current passes may be supported either by span wires crossing the street and fixed to side posts or in narrow streets to the houses, or it may be supported by side brackets projecting from ornamental steel posts some 20 ft. high. If the bracket system be adopted, the same posts can conveniently be used for lighting purposes. If the road be, say, 40 ft. broad, and a double line of tramway has been laid, the posts are best erected in the middle of the street, bearing the trolley wires on projecting arms. Such posts would resemble those used for the electric lighting of Regent street. From the wire the electricity passes to the car through the trolley, a long steel rod, with an ingenious attachment which runs smoothly along the wire.

Whether the conduit or the trolley be adopted, electric street traction has many advantages over any other system of urban transit. These may be shortly summarized as follows:

Economy of Force.—It is well known that with every kind of stage carriage there is a waste of force in restarting after stoppages. It is this which kills our 'bus horses. The electric car takes from the wire whatever force is required, no less and no more. It can thus start easily and run up hill easily. If a number of cars are worked from the same power station, the force used tends to average itself, and thus there is not the same waste of energy as in other forms of traction. The cost of the force to move a car for one mile can be reduced to less than one half-penny, as against three pence for horse traction.

Cleanliness, Noiselessness, and Saving in Wear and Tear of the Streets.—The cars move silently; there is no possibility of smoke, fumes, or unwholesome excretions. This is only possible because the force is produced in the factory instead of in the streets.

Speed.—It may not be possible to greatly increase speed in the crowded streets of central London, but even there it may be pointed out that it is a gross waste to allow valuable space to be occupied by vehicles which crawl along at the rate of five miles an hour. If the standard rate were ten miles an hour, double the number of passengers could pass along the streets in a given time. In the suburbs there is no reason why the cars should not run twelve miles an hour.

Safety.- The electric car can be pulled up more sharply and is more completely under control than any other vehicle.

Cheapness.—This is partly the result of the cheap production of force and partly the result of increased speed, enabling a larger number of passengers to be carried in the same time with the same number of cars and of men. It is calculated that with electric traction tram fares can be reduced by one-half and the gross receipts increased nevertheless by 40 per cent. The fares need not exceed one penny for three miles in populous districts, a rate which railways cannot attempt.

Why, with all these advantages, has the new invention been neglected in England?

WAVE MOTORS.

For many years inventors have been trying, with more or less success, to harness wave-power to practical use. The plans are based upon two distinct ideas—one being to utilize the progressive impact energy, the other to make use of the alternate rise and fall of the waves. A report of a promising and interesting venture comes from Los Angeles, Cal., where a small plant has been run out a few rods into the sea and some motors invented by a Mr. Porrin Wright have been installed for experimental purposes. Floats are arranged so that as they rise and fall they move the plunger of a pump. Fresh water, taken from a tank, is forced into an air reservoir, which resembles in principle, if not in form, the air chamber of a steam fire-engine or a hydraulic ram. The air being compressed causes the water to issue in a steady stream through a nozzle, and the latter is directed against the buckets of a wheel of the Pelton type. The power developed was used only in an experimental way, but it is proposed to build a transmission line four miles long to supply light and power at Redondo. The description of this plant was given in the New York "Tribune of April 17th, 1898, with the following comment: "Any system of developing power which, like the windmill or sunshine, is intermittent, is not very serviceable, unless accompanied with suitable means for storing power. And unless a wave motor is operated where there are waves every day, it, too, will require such a supplement. In the winter season, one may readily believe, there would be enough of a swell on certain coasts to keep a Wright motor running continuously. In the summer time, on the other hand, there is danger of interruption for days at a time. If it be found practicable to dispense with storage systems during the next six months as thoroughly as has been possible for the last six, an important industrial triumph will have been achieved. But if it prove necessary to fall back on enormous water tanks or electric accumulators, or to introduce a steam plant, to insure continuity of business on days when the sea is unruffled, the economy of the plan will be diminished, perhaps to the zero plant."—Ex.

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ELECTRIC TRACTION.

NOTES ON THE APPLICATION OF ELECTRIC MOTIVE POWER TO RAILWAY SERVICE, WITH ILLUSTRATIONS FROM THE PRACTICE OF THE METROPOLITAN ELEVATED ROAD OF CHICAGO.

BY M. H. GERRY, JR.

(Continued from page 22.)

The energy to overcome train resistance for the same distance is equal to 1,045,000 foot pounds. Summed up, the energy would be as follows :

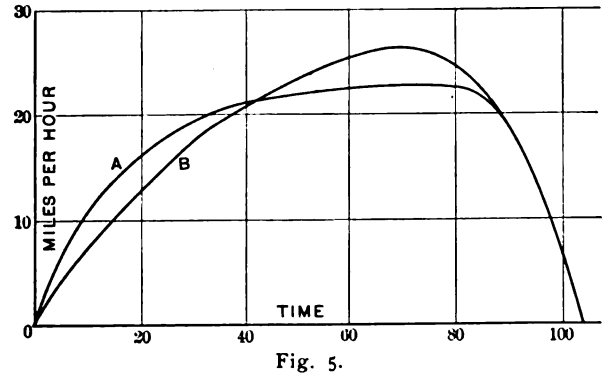

Fig. 5.

For accelerating the train,	-	3,800,000 foot pounds.
For the grade,	- -	1,900,000 " "
For train resistance,	-	1,045,000 " "
Total energy required,	-	6,745,000

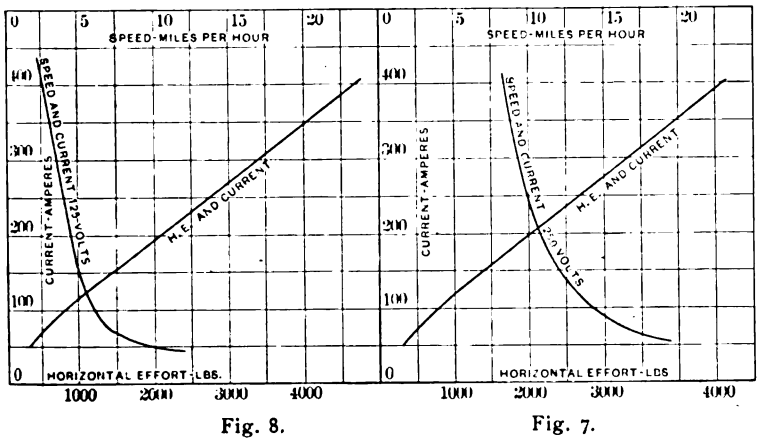

Fig. 8. Fig. 7.

This represents the total energy that must be supplied to the train from the time of starting, up to the moment the brakes are applied. From this point the acceleration is negative, and the kinetic energy of the train is absorbed by train resistance, the grade and the brakes. The amount taken up by the brakes is 2,900,000 foot pounds.

The above case is for the train on a 0.5 per cent. ascending grade. For the train on a level the figures would be as follows :

For accelerating train,	-	2,800,000 foot pounds.
For train resistance,	-	1,045,000 " "
Total energy required,		4,845,000

The amount absorbed by the brakes in this case will be 3,500,000 foot pounds.

For the same train and speed conditions for a 0.5 per cent. descending grade, the figures are,

For accelerating the train,	-	3,800,000 foot pounds.
For train resistance,	-	1,045,000 " "
Total energy required,	-	4,845,000
Supplied by descending grade,		1,900,000
Total external energy required,		2,945,000

The total energy absorbed by the brakes in stopping the train in this case is equal to 4,100,000 pounds.

The foot pounds per ton mile in each of the cases cited are as follows :

On an ascending grade,	-	142,000 foot pounds.
On a level,	- - -	102,000 " "
On descending grade,	-	62,000 " "

The average speed taken from the curves in the cases cited is 16.5 miles per hour, not including stops. Allowing twelve seconds for a stop, it is fifteen miles per hour.

The average rate of using energy or the power, allowing time for stops, is as follows :

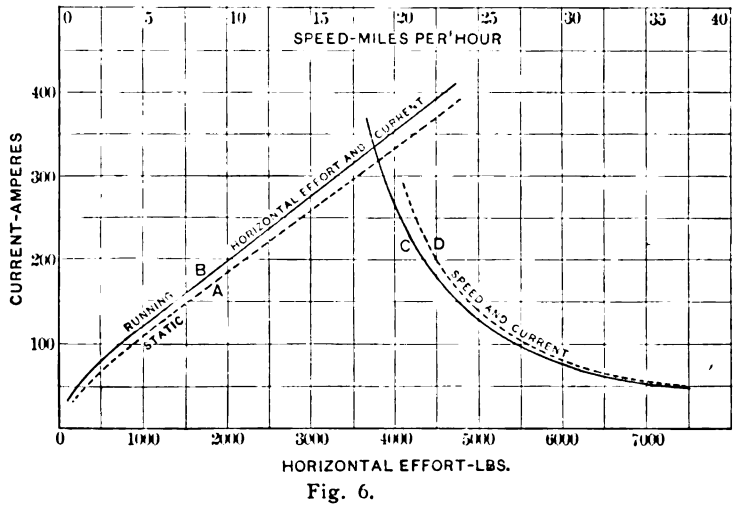

Fig. 6.

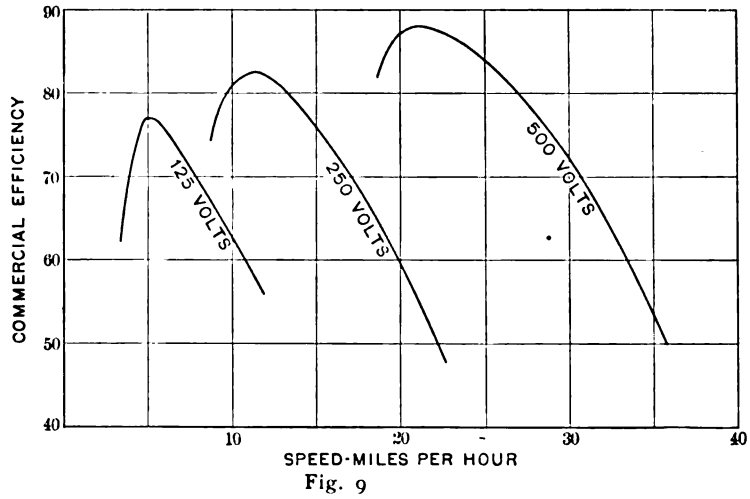

Fig. 9

On a 5 per cent. ascending grade,	-	106.5 H.P.
On a level,	- - - - -	76.5 "
On a 5 per cent. descending grade,	-	46.5 "

The power may also be divided as follows:

For accelerating the train,	- -	60 H.P.
For ascending grade,	- - - -	30 "
For train resistance,	- - - -	16.5 "

These figures do not, of course, include losses in applying the power, and only represent the energy which must be applied at the rails to produce the results in the special cases named above. The conditions vary widely at times on the same road, but the above examples may serve to show how great is the percentage of power required to accelerate the trains when the stops are frequent.

In a speed curve with a time base, such as Fig. 3, the area enclosed is proportional to the distance travelled. That part of the area enclosed by the curve from B to C, a perpendicular from the point C, and the base line, depends on the form of the braking curve and hence on the efficiency of the brakes. The area enclosed by the curve from A to C, the perpendicular and the base line, depends

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on the form of the accelerating curve. The distance between stations being fixed, the area enclosed must be constant and independent of the form of the curves. The shape of the curve may be altered, however, in two general ways, first by changing its form so as to still enclose the same area, with the same length of base, and secondly, by altering the form of the curve and changing the length of the base. This latter change will alter the time between stations, while either of the changes may or may not affect the amount of power used, this depending principally on the maximum speed attained. In Fig. 5, the curves A and B represent equal distances passed over in equal times, but the energy required for curve A is materially less than for curve B. The amount of power required in any case will depend largely upon the form of the speed curve, that is, upon the rates of accelerating and retarding of the train, and it is always desirable to keep the maximum speed as low as possible.

The Motors and Controlling Apparatus.

At the present time, direct current series motors with series-parallel controllers are in all but universal use for electric railways. Shunt motors are in service in Europe to a limited extent, and alternating current motors have been given a trial. The latter have advantages under certain conditions for lines of considerable length where there are but few stops. Alternating current motors tend to run at a nearly constant speed, approaching synchronism, and do not regulate with the same facility and efficiency as direct current motors. They develop, however, a good starting torque and may even produce a better form of torque-speed curve than the common series motors. The double conductor required with alternating current motors is an objection, but there are many advantages in their favor; the system is untried and its possibilities are not fully known.

The characteristics of the motors in use on the Metropolitan Elevated are introduced in this paper rather than a general discussion, and it is hoped that this will be acceptable. By modifying the design the relations existing between the torque, speed, current and voltage may be varied within wide limits, but the general relations are always the same and are well illustrated by the diagrams below. All modern railway motors are much alike, the designers having been forced by the conditions imposed upon them into practically one general type of machine. The requirements are a large output, ability to withstand heavy overloads, freedom from sparking, a low rotative speed, light weight and limited space. The result is the cast-steel multipolar motor, operating with nearly saturated fields and high magnetic densities in the armature.

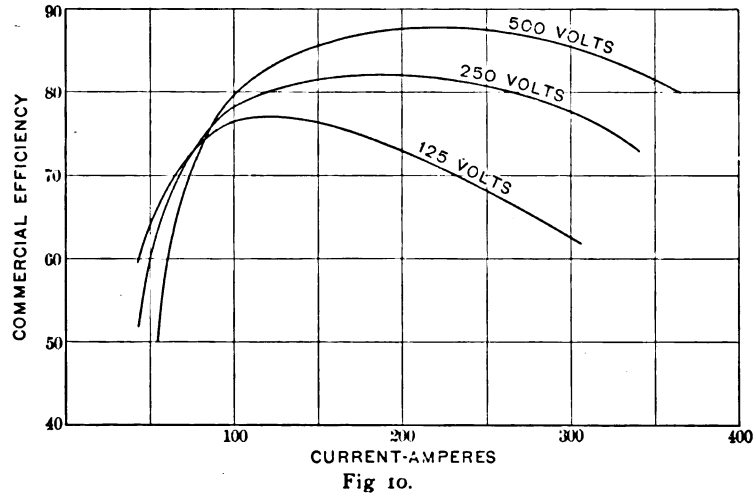

Fig 10.

Motors efficient at high speed are sometimes wasteful of energy because of insufficient torque, at starting and at low speeds, to produce a good form of acceleration curve.

The train weight may be considered as made up of two parts, the live, or paying load, and the dead load, which includes the weight of rolling stock, motors, etc. As the amount of power required by the train varies almost directly as the weight, it is desirable to have the non-paying or dead load as small as possible. In order that there may be sufficient traction, a separate locomotive must weigh between four and five times the maximum drawbar pull required by the train, all of which is dead load, in addition to that of the cars. It has been stated that a rapid acceleration is desirable if there are many stops, but as each pound of increased maximum drawbar pull from a locomotive must add four or five pounds to the dead weight of the train, a point is soon reached where no further advantage is obtained by increasing weight on drivers and drawbar pull. The weight admissible on the locomotive driving wheels, on account of track and structure, also limits the amount of traction, hence the drawbar pull and rate of train acceleration. Thus, for a service combining high speed and many stops, there are advantages in a form of motor which may be so placed as to utilize a part of the car weight and live load, for purposes of traction. The cars should weigh as little as possible, so as to reduce the total dead weight of the train, for it is well known that the ton-miles of paying load form only a small percentage of the total ton-miles moved. On elevated roads it is probably below six per cent. on the average, and on some roads below one per cent.

It is hoped that these remarks may direct attention to the question of economy in the use of power or to what may be called train efficiency, in contradistinction from the efficiency of the apparatus used in the generation and transmission of the power to the car axles. This latter subject will now be considered.

In electric motors the relations between speed, horizontal effect (or torque), current, voltage, and efficiency are all fixed, and may be readily determined for any particular motor. For most practical purposes it is best to represent these relations graphically. At A, in Fig. 6, the relation between current flowing and the static horizontal effort produced, is shown for the standard motors in use on Metropolitan Elevated Road. Curve B, in the same figure, represents the horizontal effort produced when the motor is running with 500 volts at the terminals and at the speeds shown by C. The horizontal distance between A and B represents the loss in horizontal effort due to friction and core losses. Curve D, in the same figure, gives the speeds which the motor would attain under the conditions named if there were no internal resistance, and the horizontal distance between the latter curve and C represents the loss in speed due to such resistance. Thus the losses in a series motor may be divided into two classes, those that lessen the torque and those that reduce the speed. In Figs. 7 and 8 the relations between current, speed, and horizontal effort are plotted for the same motor at 250 and 125 volts. The static horizontal effort is the same in all cases, but the running horizontal effort is slightly greater for the same current

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ELECTRICAL PROGRESS IN MONTREAL.

The large cities of the United States have been receiving so much attention the last few years on account of the rapid growth of electrical industries within their confines that other sister cities in a land that is one with us in its love of liberty and high ambitions have been forgotten. The Canadian Electrical Association, the programme of whose proceedings was published several weeks ago in our columns, attended their annual banquet at Montreal not quite two weeks ago. The mayor of Montreal delivered a toast entitled, "Electrical Montreal and the City of Montreal," which showed an intimate acquaintance with the development of electric light and power concerns in that city. The statistics he gave were as follows:

The Royal Electric Company began in 1884 with a dynamo of twelve arc light capacity, a dozen employees, a small workshop, and a capital of less than $50,000.00. Today it has a manufactory covering an area of about 40,000 square feet. The total employees of the company in its manufacturing business is upwards of 5,000; its capital investment upwards of $2,500,000.00. The mayor further stated in substance that Montreal was first illuminated in 1886 by electric light, only 113 being in use at that time. At present there are more than ten-fold as many, at least 1,500 representing the total. The mayor spoke of the transmission plant being erected by the Chambley Manufacturing Company, whose intention it is to send 20,000 H. P. into the heart of Montreal for distribution as required. The Lachine Hydraulic & Land Company's enterprise, representing an investment of $2,500,000.00, whose object is the harnessing of the St. Lawrence River for the benefit and betterment of Montreal.

The street railway plants of Montreal were referred to, and the mayor stated that in August, 1892, two dynamos, whose combined capacity equalled but 500 H. P., represented all that was being done in the line of electric traction. At the present time 10,000 H. P. is being generated; miles upon miles of track are in use. The development in other directions, including the telephone, has become something enormous, Montreal bidding fair to rival in the extent and significance of such improvements the greatest cities in the United States. It is gratifying to realize that the signs of greatest progress are visible only on this side of the Atlantic. Our European friends can see year by year tremendous advances, which include every imaginable department and every application of electricity. The heaviest electrical machinery is now being shipped to England herself, at one time the greatest source of manufactured articles in the world, but today beginning to be dependent upon America for many of the things she originated and made herself.

The transplantation of commercial centres from the old world to the new became inevitable when the natural resources of this country were fully appreciated. The tide of improvement has kept pace with civilization, and moved westward with resistless force. The commercial activity in this country is not one iota of what it will be a century hence, Canada included, and we feel safe in prophesying that of the millions upon millions of dollars circulating from centre to centre a large percentage will be devoted to electrical manufacturing.

The development of a useful science cannot be anticipated because of the mysteries that lie hidden beyond. Inventions that may yet thrill the nations are inchoate and unthought of. Ideas which, when crystallized, will give employment to thousands of men are still unborn, but the life-blood of trade circulating and pulsing through this great nation is building up new and healthy tissue, giving body and form to this country of surpassing magnificence.

THE NATURE OF CONDUCTION.

The constant vibration of all matter is merely a proof of the continuity of the great chain of force extending through the universe. The phenomena of conduction is certainly a vibratory action of a systematic nature controlled by a form of energy in itself but superficially understood, yet which gives rise to secondary effects most familiar to our senses. Heat and ultimately light appear in response to its influence, showing, as it were, that a moving current induces changes in conducting bodies which could have been created by the direct application of friction, transmitted heat or by chemical action. The conduction of heat, in many respects, is analogous to the conduction of electricity. It differs from it in its slowness of transmission and immense loss by radiation.

The nature of electric conduction will never be known until a thorough analysis is made of those peculiar forms of vibration which constitute heat, electricity and light. The interaction of a material particle, so called, upon the ether is so little within our true sense of appreciation that theories, explanations and abstract conclusions of any description are useless.

A study of molecular physics, a knowledge of the mechanics of heat and a review of all great works touching upon the ultimate effect of force upon matter will prepare the mind for a careful consideration of the cause of conduction and possibly lead us to anticipate the inherent nature of this remarkable phenomenon.

London, Ont.—Application will be made to the Parliament for an act to incorporate a company to construct an electric railway from this city to a point near Grand Bendon, Lake Huron.

Rimouski, Que.—A company has been formed to construct a telephone line from this place to Matane and work will commence in the spring. The promoters are J. Elzear, G. Martin and others.

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at the lower voltages, because the losses which affect it are less at the lower speed. At the same time the percentage of loss due to internal resistance becomes greater, as it depends upon the current flowing, while the total input of energy varies with the electrical pressure as well; hence, the reduced efficiency at the lower voltages. Curves of efficiency, in relation to the current, are plotted in Fig. 9 for the same voltages.

In Fig. 10 the efficiency is plotted to the speed, and it will be seen that the curves fall off rapidly above or below a certain narrow range of speed over which the efficiency is high, at any one voltage. There is a considerable range of current and horizontal effort over which the efficiency is high, as can be seen from Fig. 9, but it corresponds to only a small speed variation. The relations of speed to horizontal effort are given in Fig. 11. The maximum working range of the motor is from 350 to 4,000 pounds horizontal effort, and the total speed variation on this range at 500 volts will be about 14 miles, and at 250 volts about 10 miles. The range of speed obtained in service at any one voltage is practically about one-half this amount, and if 250 and 500 volts be considered as the pressures at the motor, in series and parallel combination, then the total range of speed, without further alteration of the voltage by resistance in circuit, will be about 12 miles over a total speed range of 34 miles. For each combination of motors in series parallel, there is a certain range of speed over which the efficiency is equal to that of the motors; but at all other speeds resistance must be introduced in circuit, and the efficiency is reduced.

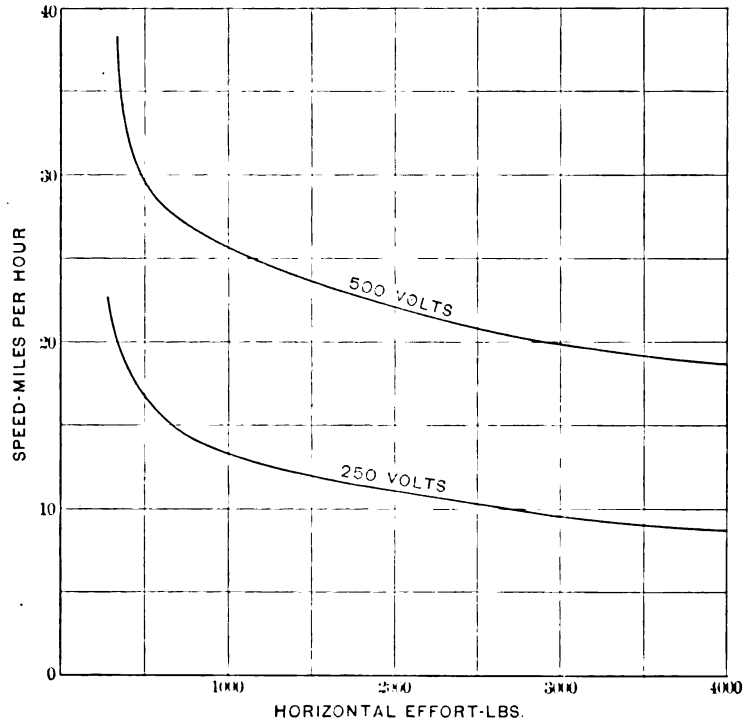

Fig. 11.

The weight of the armature and other revolving parts is a feature of importance in motors designed for a high-speed service requiring frequent stops. These parts should be as light and the rotative speed as low as possible. The armatures of the Metropolitan motors weigh approximately 1,400 pounds and are 18½ inches in diameter. At 800 revolutions per minute, corresponding to 25 miles per hour, the kinetic energy in each armature is equal to 43,000 foot pounds. Thus, for a two-motor equipment, 86,000 foot pounds of energy are dissipated each time the car is stopped from a speed of 25 miles per hour. This amount of energy will vary with the square of the maximum speed, and, if stops are frequent, it becomes an appreciable loss.

The average load a motor is capable of sustaining is fixed by the permissible increase in temperature. The amount of such increase will depend on the average load, the efficiency of the motor and the extent and character of the heat radiating surfaces. The actual load on a railway motor differs, at times, very widely from the average load, and ability to withstand these fluctuations will depend in part on the heat storage capacity of the motor. The metal acts to a considerable extent as a reservoir of heat, receiving it when the motor is doing its heaviest work and giving it up at lighter loads. A glance at the load diagrams in the latter part of this paper will serve to show how great these fluctuations may be under certain conditions. The amount of heat radiated in a given time varies greatly with the speed of the car and the temperatures. With the air at 60° F., and under average working conditions, a Metropolitan motor will radiate heat at the rate of about 650 British heat units per minute. This is equal to 15 horse power, corresponding about to 60 horse power of loading. But these motors will readily withstand for a considerable period of time a loading of three times this amount. Most of the heat produced by this additional loading must be stored in the metal of the armature and frame. A considerable part of the heat is generated in the armature, but its thermal capacity being nearly 150 heat units per degree, a large amount of heat energy can be stored before the temperature reaches the danger point. Slow speed armatures in general have more metal in them, and are thus better able to stand a variable load.

(To be continued.)

SOME PHASES OF THE RAPID TRANSIT PROBLEM.*

BY ALBERT H. ARMSTRONG.

The rapid transit problem, in congested districts, has to deal with the transportation of passengers at a high average speed with frequent stops, and even in suburban traffic where the stops are less frequent the schedule speeds have been so increased by the ability of the electric motor to accelerate rapidly, that trains hardly reach full speed before it is necessary to apply the brakes. As running at a constant speed does not occur in rapid

* Paper read before the American Institute of Electrical Engineers, Omaha, June 28, 1898.

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transit service where stops are at all frequent, it becomes of the greatest importance to carefully investigate the subject of train acceleration in order to determine the method of running a train from station to station with the least expenditure of energy.

Problems in train acceleration may be divided into two broad classes: 1. Where the road is level, and

2. Where grades exist or where an artificial profile is made in order to take advantage of down grades at starting.

Modern passenger cars demand a dead weight of approximately 550 lbs for each passenger carried, or, in other words, only 20 per cent. of the total weight of a loaded motor car is a paying load. When it is considered that in rapid transit service with frequent stops, over 80 per cent. of the total energy output of the motive power on level roads is required to accelerate the train, it is evident that in this class of service the rolling stock requires the greatest attention.

To avoid undue complication, the following discussion has assumed that train friction is a constant quantity at all speeds, as at the low maximum speeds—20 to 30 miles per hour—reached in practice with frequent stops of two or more per mile, the error introduced by assuming a constant friction rate will be small and will not at all alter the conclusions arrived at.

The following constants have been assumed as representing average operating conditions:

Length of run, 2000 ft.

Length of time train is is motion, 75 seconds.

Schedule speed, 16.05 miles per hour, including 10-second stops, or 85 seconds total time.

Tractive effort, 100 lbs. per ton total, to be maintained uniform during acceleration of the train.

Braking effort, 150 lbs. per ton constant throughout the period of braking.

The train friction being 15 lbs. per ton, reduces the effective accelerating force from 100 to 85 lbs. per ton, corresponding to a rate of .927 miles per hour per second.

With this data a simple acceleration curve, as in Fig. 1, may be calculated, the train reaching a maximum speed of 28 miles per hour in 30 seconds, when power is shut off and the train allowed to coast with a retardation due to friction of .1635 miles per hour per second for 31 seconds to the braking line, when it is retarded at a uniform rate of 1.625 miles per hour per second and comes to rest in 75 seconds from time of starting.

Owing to the greater efficiency of the run, the train is allowed to coast after reaching its maximum speed rather than to allow it to continue at a uniform speed with just sufficient power supplied to overcome the train friction loss.

It is obvious that the train could be accelerated at a different rate than that corresponding to 70 lbs. per ton and still make the same length of run in the same time, the length of time occupied in coasting depending upon the rate of acceleration, being a maximum with an infinite rate, that is, with the train starting with a certain initial velocity. A minimum rate of acceleration is reached when no time is left for coasting, that is, when brakes are applied as soon as power is shut off.

In Fig. 2 such a set of curves has been prepared, showing a train covering a distance of 2,000 ft. in 75 seconds, as before, but accelerating at various rates from that

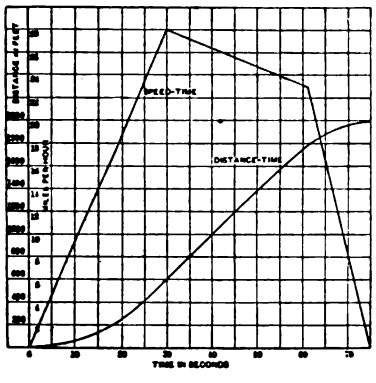

FIG. 1.—ACCELERATION CURVE

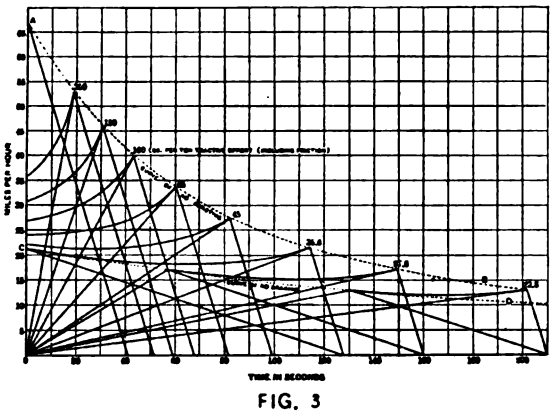

FIG. 3

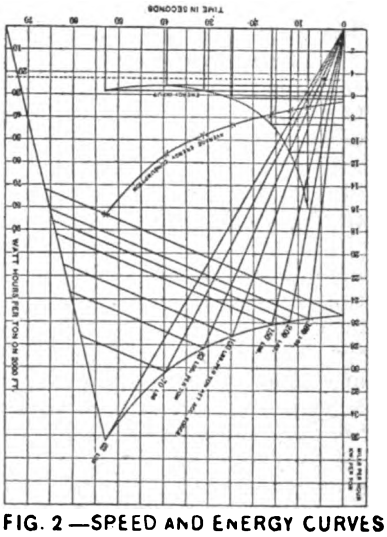

FIG. 2—SPEED AND ENERGY CURVES

Distance, 20.0 ft. Time, 75 secs. Tractive effort, 100 lbs. per ton. Friction. 15 lbs. per ton. Braking effort, 150 lbs per ton

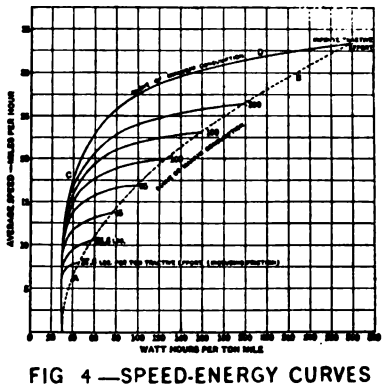

FIG 4—SPEED-ENERGY CURVES

Distance, 2000 ft. Time, 75 seconds. Starting grade of 4 per cent. Tractive effort of motor, 100 lbs. per ton. Friction 15 lbs. per ton. Braking effort, 150 lbs. per ton.

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corresponding to 62.8 lbs. per ton as a maximum up to an infinite rate, or starting with an initial velocity of 25.2 miles per hour.

As the area inclosed by time as abscissæ and speed as ordinates represents the distance covered, this will be a constant quantity for the fixed distance of 2,000 ft. assumed, and curves of Fig. 2 are thus constructed with the same inclosed area for each rate of acceleration. The fact is plainly brought out that with a low rate of acceleration a much higher maximum speed is demanded than would be the case if the rate had been increased, and a curve may be plotted by joining the maximum speeds reached for different accelerating rates, as shown.

A friction of 15 lbs. per ton has been chosen as being that of an average train composed of a motor car and three or four traillers and weighing about 120 tons. With heavier and longer trains this rate may be reduced to as low as seven or eight pounds per ton, while for a motor car alone, the rate may be as low as 30 lbs. per ton, due to friction of motors and gearing. The braking effort of 150 lbs. per ton is also chosen as representing what can be done on an average by a train equipped with air brakes and operating at half the slipping coefficient of the wheels.

It is advisable in rapid transit service to keep the maximum speed reached by the trains as low as possible, as this class of work generally calls for a short time-interval between trains where the utmost precautions are necessary to keep the trains a safe distance apart. In fact, the maximum speed required for a given run practically determines the time-interval between trains, as the train headway should be at least five or six times the length of time required to bring a train to rest from its maximum speed with normal braking force applied.

A second reason for higher rates of acceleration lies in the fact that with rates of acceleration approaching the minimum no margin is left for errors of judgment of the motorman, as little or no time is left for coasting, and the rate of acceleration per amp. input is continually varying with the changing passenger load, and hence with an overload it becomes difficult to maintain schedule speed.

A third and most important objection to the use of a low rate of acceleration lies in the saving of energy for the run by the use of a higher rate.

Neglecting $I^2 R$ and core losses of the motors, a set of energy input curves per ton weight of train may be plotted as in Fig. 2, assuming for simplicity that motors are series wound, operate all in multiple and are so geared that starting resistance is entirely cut out at the various maximum speeds reached in the various runs, that is, that no acceleration is done on the motor curve. A constant impressed e. m. f. is assumed, and starting resistance is supposed to be cut out proportional to the motor speed, thereby keeping the current and torque constant.

Thus it is seen that accelerating a train with the minimum rate calls for the highest maximum speed, demands nearly the least current input and also demands the greatest waste of energy in the brakes, as the speed is a maximum when brakes are applied.

The areas inclosed by the various energy time curves represent the comparative amounts of energy required for the run for the different rates of acceleration and these are plotted in Fig. 2, which compares the energy input and the average energy consumption for the run of 2,000 feet in 75 seconds for all rates of acceleration from the minimum corresponding to 62.8 lbs. per ton up to infinity.

For convenience the average energy rates are plotted in terms of watt hours, and the curve shows that while the minimum rate of acceleration corresponding to 62.8 lbs. per ton calls for an expenditure of 83.5 watt hours per ton weight of train, this is reduced to 56.5 watt hours by accelerating with a rate corresponding to 70 lbs. per ton, to 42.7 watt hours with 100 lbs., and finally reaches a minimum value of 32.5 watt hours if the accelerating rate is pushed to infinity.

Thus the energy required for the run of 2,000 ft. in 75 seconds may vary from 83.5 to 32.5 watt hours per ton of train weight, a decrease of over 60 per cent., depending upon the rate of acceleration used.

The curves in Fig. 2 are worthy of careful study, and similar curves afford a means of determining the proper rate of acceleration and hence motor equipment, gearing, etc., to use for a given set of conditions. The limiting factor in the more rapid rate of acceleration of a train is the current input required. Thus, if the rate of acceleration be carried to abnormally high values, the local demand for current becomes so great that either the loss in the feeders more than offsets the reduction in energy consumption at the train, or else the interest on the increased feeder investment is not offset by this energy reduction.

There are other limiting factors governing the rate of acceleration in the size and weight of motors, which are limited in the current they can carry without undue sparking and heating. Thus it will be found that the rate at which a train accelerates largely determines the cost of feeders, size of motors and generators, both in regard to current and thermal capacity, and also fixes the safe headway between trains.

The error made in accelerating at or near the minimum rate is clearly brought out. For example, the current consumption per ton is the same for 62.8 lbs. per ton or 85 lbs. per ton; as, although 85 lbs. calls for the greater tractive effort, the torque per amp. is so increased by the lesser maximum speed demanded that the current input is the same in each case; hence the feeder considerations are the same in both cases, while the energy consumption shows a reduction from 83.5 watt hours per ton, with 62.8 lbs. to 47.5 watt hours, or about half, with 85 lbs. per ton.

Referring again to Fig. 2, it is obvious that a similar set of curves may be plotted for a run of 2,000 feet for any other length of time than 75 seconds, and Fig. 3 gives such a set of curves plotted for lengths of time ranging from 41 seconds, as a minimum possible, up to 210 seconds. The minimum time in which it is possible to make a run of given length is determined by the braking effort, in this case assumed to be 150 lbs. per ton, the train reaching a maximum speed of 66.5 miles per hour in zero seconds, with an infinite accelerating force, and being retarded throughout the entire running time of 41 seconds at the rate of 1.635 miles per hour per second, corresponding to a force of 150 lbs. per ton braking effort.

The constants assumed in these curves are the same as before, 15 lbs. per ton friction rate, and 150 lbs. per ton braking effort applied uniformly until the train comes to rest at a distance of 2,000 feet from the start. While the braking effort determines the minimum length of time for the run, the friction rate imposes a limit upon the maximum rate of acceleration possible for lengths of time greater than 128 seconds for 2,000-foot run. That is, a train accelerating with an infinite rate and coasting the entire length of 2,000 feet, would come to rest in 128 seconds with no energy loss in the brakes, and any longer interval of time occupied in the run would require some finite rate of acceleration at a maximum. This is pointed out in Fig. 3, where for a run in 210 seconds the maximum rate of acceleration possible is .175 miles per hour per second, corresponding to 24 lbs. per ton. No train in practice would require such a long time as 210 seconds, nor would it be possible to make a run of 2,000 feet in 41 seconds, but these curves have been carried out to show the limits for a given set of conditions.

As the energy lost in braking is proportional to the square of the speed when the brakes are applied, the curve A—B, Fig. 3, being the locus of the minimum rates of ac-

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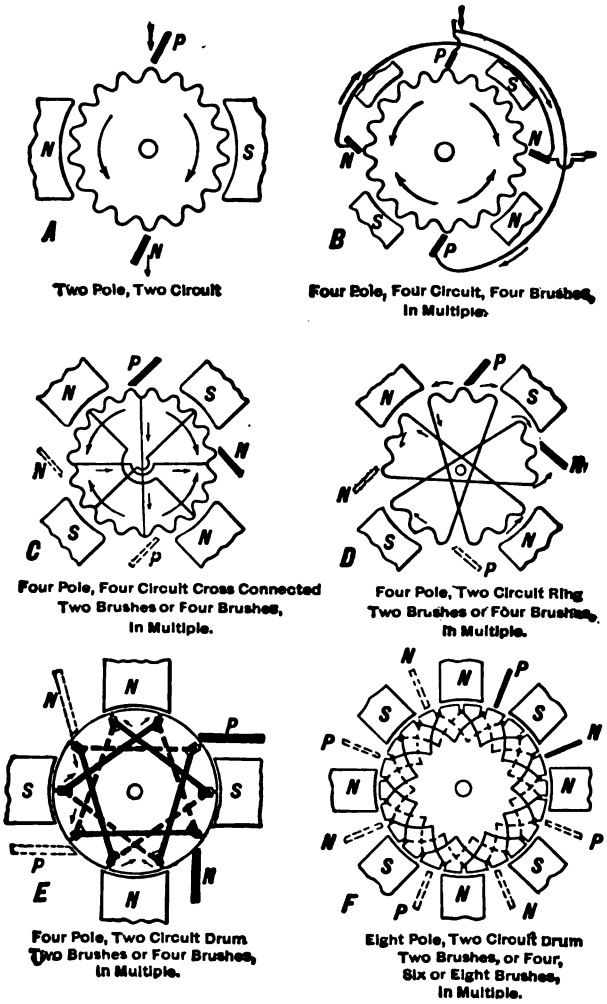
celeration, that is, with no coasting, is thus the curve of maximum input for a run of 2,000 feet for any length of time. Also the curve C—D, being the locus of the various coasting lines, that is, of no braking effort, is thus the curve representing the minimum possible input.

To compare the amounts of energy required for rates of acceleration other than the maximum and minimum, a set of curves has been prepared in Fig. 4, giving the energy consumption for a run of 2,000 feet on a level track for any rate of acceleration and for any length of running time, the constants being 15 lbs. per ton friction rate and 150 lbs. per ton braking effort. For convenience in comparison, the energy consumption is reduced to watt hours per ton mile, and speed is expressed as average speed in miles per hour while train is in motion or equaling schedule speed if train loses no time in stopping. The dotted curve A—B is the maximum energy curve corresponding to the curve A—B of minimum rates of acceleration in Fig. 3, and the curve C—D represents the minimum amount of energy possible for the different speeds and is described by an infinite rate of acceleration. The curves of maximum and minimum energy consumption approach each other and coincide at a speed of 33.3 miles per hour, corresponding to an energy consumption of 298 watt hours per ton mile, this value being the greatest amount of energy that can be expended on the run with 150 lbs. per ton braking effort.

All energy values are net; that is, they represent the amount of energy required to accelerate the train plus energy lost in overcoming friction, and hence take no account of any losses occurring in actual operation in the motors, rheostats, gearing, etc.

Fig. 4 shows the economy resulting from properly proportioning the accelerating rate to the schedule speed and distance traveled. For example, a train accelerating with a tractive effort of 100 lbs. per ton and making 20 miles per hour average speed, not including stops, will require 127 watt hours per ton mile, which would be reduced to 65 watt hours per ton mile if the tractive effort had been increased to 150 lbs. per ton, or, in other words, the generator capacity would be but half as large for the same service.

The curve of 300 lbs. per ton tractive effort is interesting, as it represents about the maximum speed attainable with modern apparatus for a distance of 2,000 feet with the assumed constants of friction and braking effort. Assuming the entire weight of the car to rest upon drivers, about 300 lbs. per ton would be available for traction without slipping the wheels on an average track, so that an average speed of 26½ miles per hour is the highest that could be obtained over a distance of 2,000 feet, not allowing any time whatever for coasting.



Principles of the Connections in the Different Types of Armatures.

All previous curves have been based upon the assumption that trains are allowed to coast after reaching maximum speed, and also that acceleration is carried on at a perfectly uniform rate until power is shut off, but in practice this assumption may be modified somewhat, the starting resistance being cut out before the maximum speed is reached, and the latter part of the acceleration carried on at a constantly decreasing rate upon the motor curve.

(To Be Continued.)

THE DESIGN AND CONSTRUCTION OF DYNAMO-ELECTRIC MACHINES.

Columbia University is illuminated at night by large generators, the design and construction of which is the

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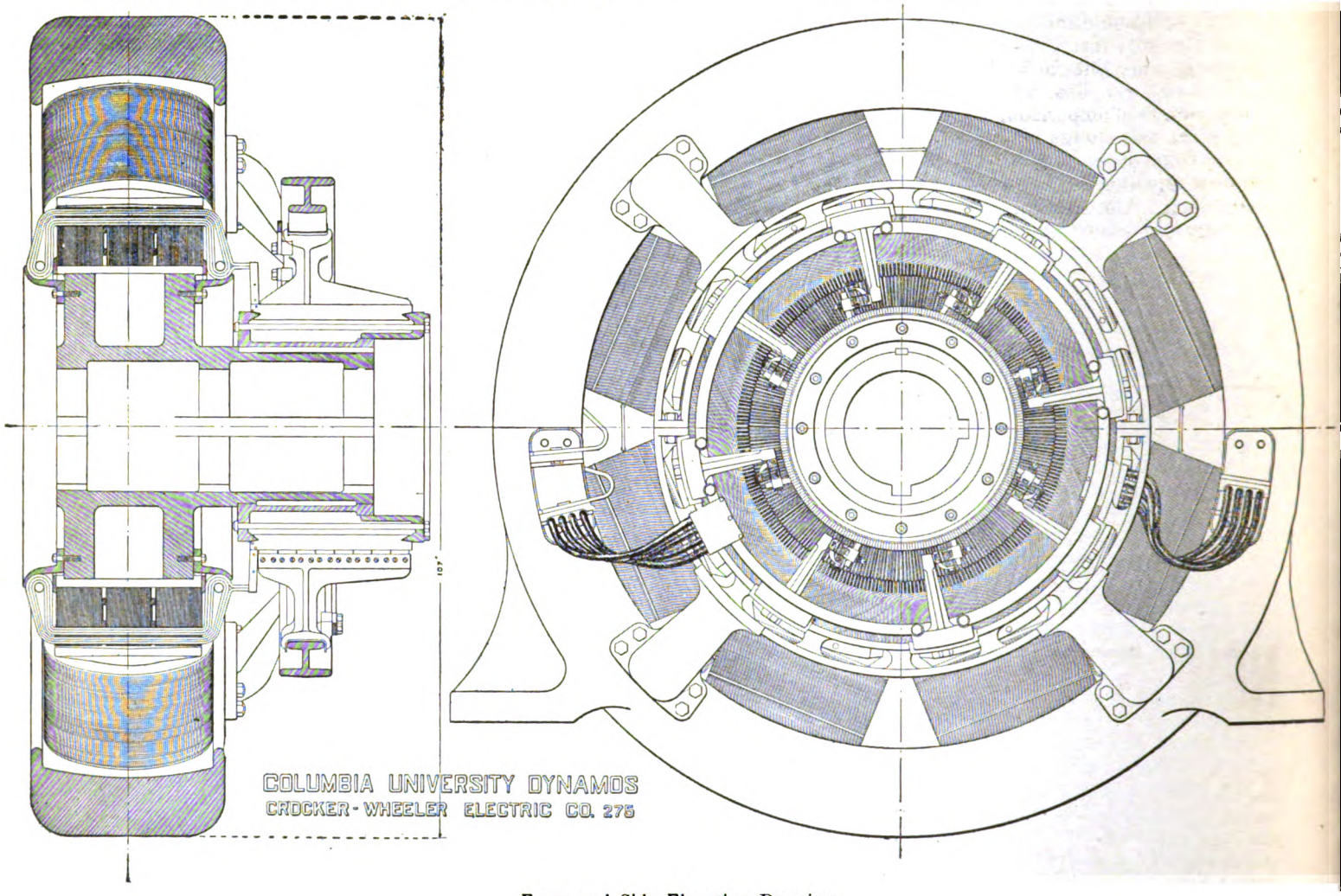
work of two of its graduates, Messrs. Crocker and Wheeler, of the well-known company bearing that name. The general details of construction are shown in the accompanying sketches. The multipolar dynamo within the last ten years has gradually usurped the place once occupied by great two-pole machines. Originally a prejudice existed against the multipolar dynamo, and in one, having a common armature and commutator. The combinations that can be made with the armature winding are very numerous, the standard text books containing a great variety of illustrations bearing upon the subject. The weight and output of a given amount of material have been almost doubled since the use of mild steel for frames is in vogue. The causes of sparking,



Front and Side Elevation Drawing.

various technical objections were brought forward against its use. But they have long since vanished, and the most satisfactory and most economical piece of machinery we have is the multipolar generator.

The connections of the armature of a multipolar generator are simple enough when represented in the manner shown. Generally speaking, there are two classes of windings, wave and lap, each of which may be used in the armature of a multipolar machine or a combination of them. The ordinary bipolar dynamo using two brushes possesses two circuits in its armature, as shown in the upper left-hand sketch. The simple form of multipolar winding of the same description simply doubles the number of circuits, necessitating the use of four brushes, as shown in the upper right-hand corner. The armature winding in this case is called lap winding. The four cases below are those of wave winding essentially, merely cases in which the windings are connected in such a manner that full pressure may be obtained as well from the entire current as from any two of the brushes indicated.

It would be very difficult to construct commutators and brushes of sufficient size to carry large volumes of current without heating; consequently in the majority of cases as many brushes as poles are used, thus reducing an otherwise inevitable expense in the construction of the commutator.

A multipolar dynamo is merely two or more dynamos

the prevention of heating, and the construction of the commutator are now so well in hand by electrical artisans that the heaviest machinery operates noiselessly, sparklessly, and without perceptible wear at the end of a yearly run. The science and art displayed in the different types of electrical machinery put upon the market by the Crocker-Wheeler Electric Company indicate a thorough grasp of the details of construction by those entrusted with that department of work.

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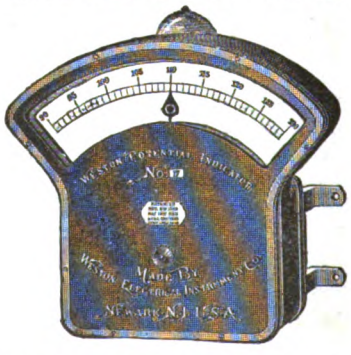

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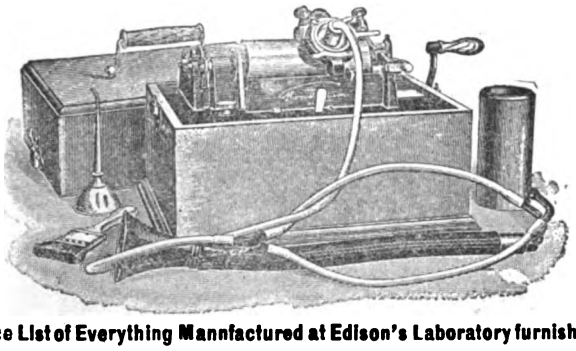
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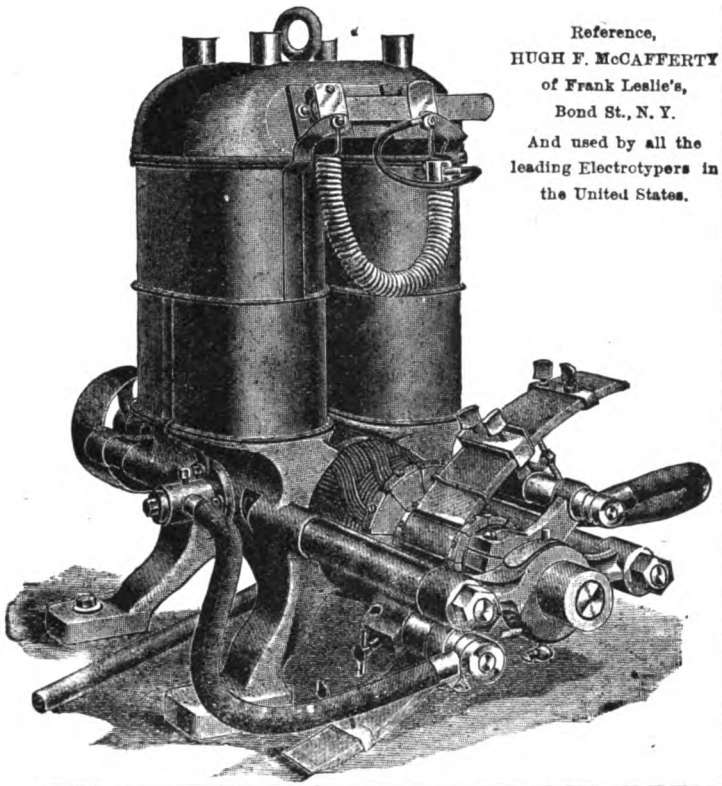

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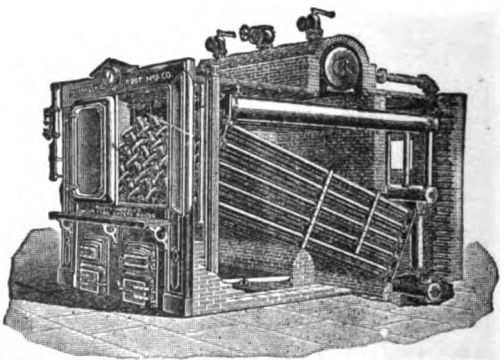

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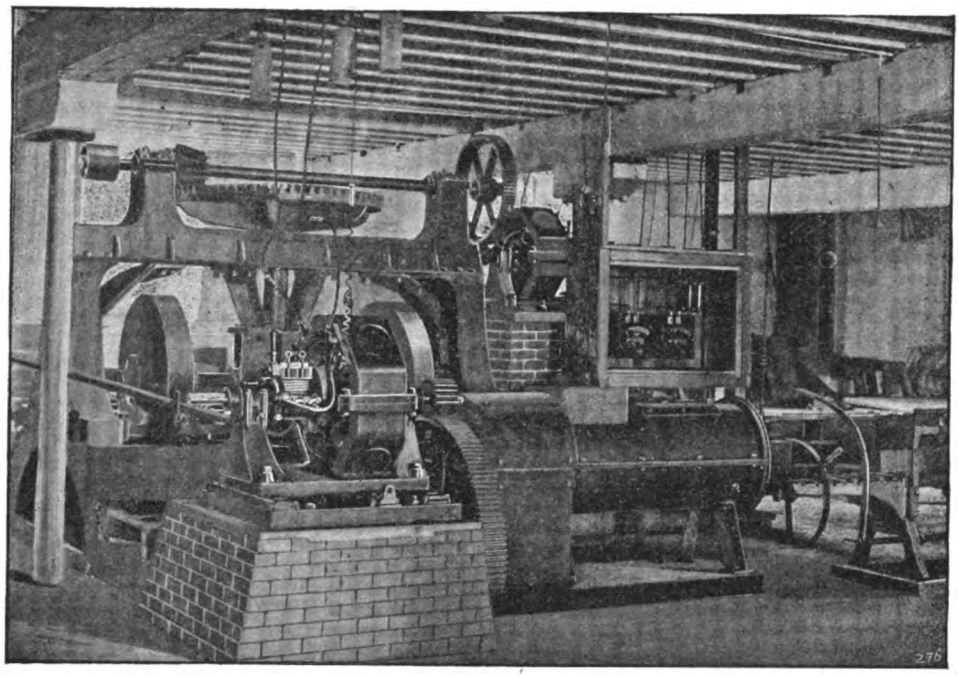
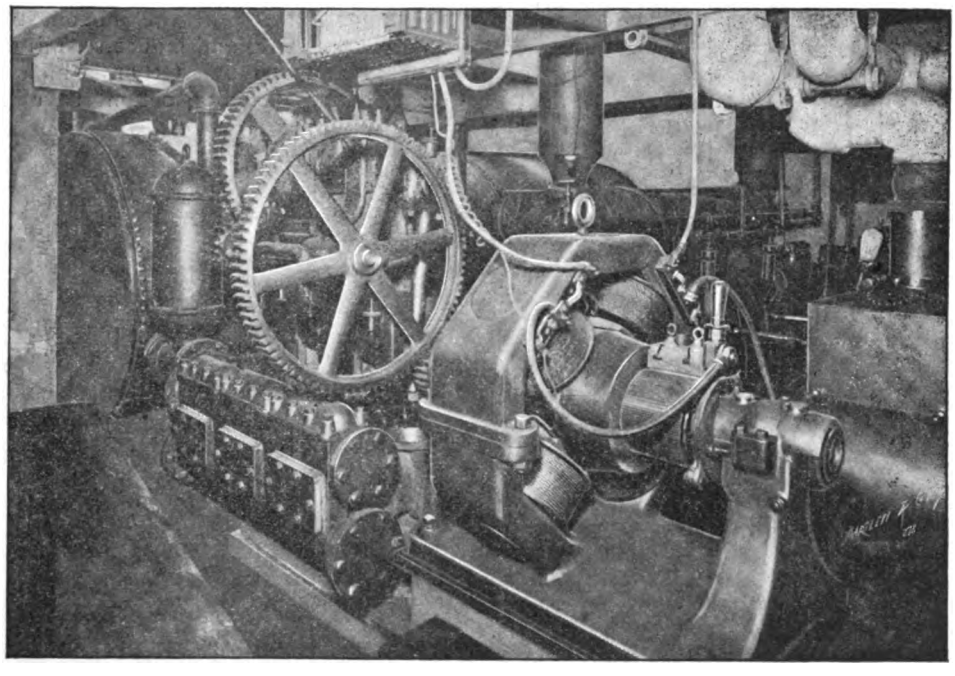
The Electrical Age.

VOL. XXII—No. 4 NEW YORK, JULY 23, 1898 WHOLE No. 584



Motors on Brick Clay Mixer, Catasauqua, N. Y.



Motor on Triplex Pump, Granite City Steel Company, Granite City, Ill.

THE INCREASING USE OF DIRECT-CONNECTED MACHINERY FOR ELECTRIC LIGHT AND POWER.

The great change that has taken place in the department of electrical engineering in the use of direct-connected machinery is becoming more marked day by day. The application of electrical machinery to industrial purposes has exercised a great influence upon the development of certain industries and the cost of manufacturing. In many cases two lines of trade run parallel and become in the course of time dependent upon each other. It has been noticed by broad-minded critics that the gas-engine industry, like the refinement of mechanism in the high-speed steam-engine, should attribute a large share of its development and present perfection to the use of dynamos, in conjunction with which their sales have increased.

Certain modifications have been effected in the design and construction of motors and dynamos for direct-connected work. The dynamo, when driven by gas-engine, is frequently supplied with a fly-wheel belt pulley whose use is obvious. In other respects the dynamo is rarely, if ever, changed to meet external conditions, its normal construction being amply sufficient for all cases generally met with. The motor, however, has been greatly used in connection with air compressors, clay mixers, pumping machinery, etc. It is necessary to state right here that the direct connection of a motor to a piece of machinery is never a matter of trifling importance.

The general operation of the machine, pump, etc., to

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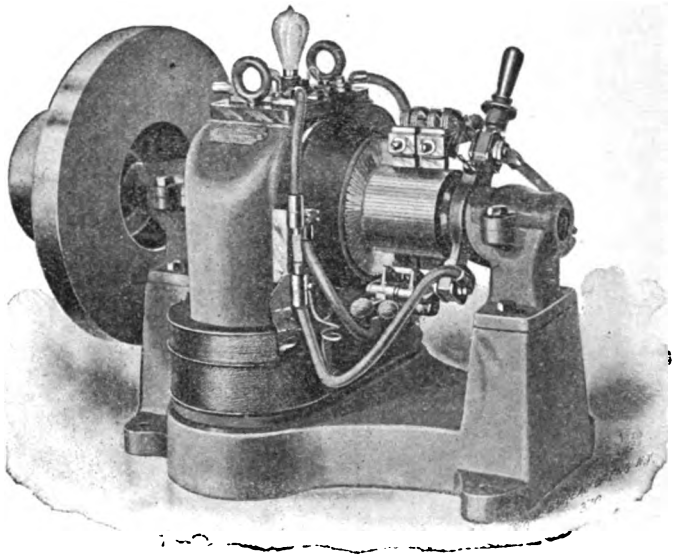
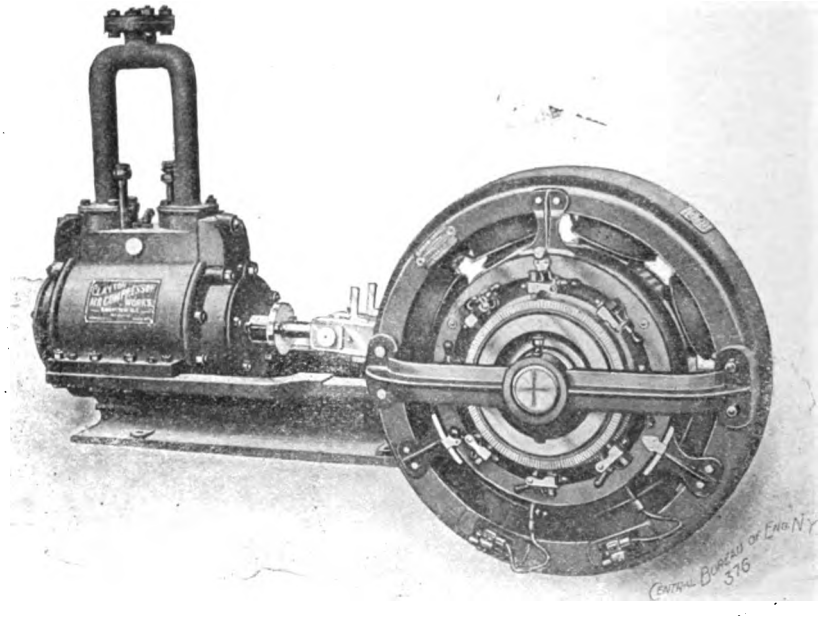
which the motor is to be connected must be carefully studied and a true knowledge gained of the variations of load, its maximum and minimum, and the gener l economy resulting from the combination. It is not true that in every case the motor can be applied to a piece of machinery with a saving of far-reaching economy. Certain cases exist in which the use of the motor would involve complications and cause serious inconvenience to those entrusted with its care.

Machines operated by compressed air sometimes displace electrical machinery. Such cases as these are rare and their introduction and use is entirely due to the fact that fresh air such as compressed air machinery would deliver is necessary for hygienic purposes. The use of direct-connected electrical machinery for light and power is growing daily. Many of the obstacles that oppose progress have been swept aside by the inventive genius of our own people.



Compound Dynamo with Fly-Wheel Belt Pulley for driving by Gas Engine.



Direct Motor connected to Clayton Air Compressor.

Westfield, N. J.—The Key West Electric Co. has been incorporated by Harry E. Knight, William E. Knight and David J. Newland. Capital stock, $300,000.

Lyons, Mich.—An electric-light and power plant is to be constructed.

RARE MINERALS.

The best incandescent gaslight, the Auer light of the Auer Company in Berlin, has a mantle consisting of 99 per cent. oxide of thorium and 1 per cent. oxide of cerium. This small amount of cerium oxide increases the power of the mantle fifteenfold. "Invention," of London, also remarks that the most important minerals, from the point of view of the incandescent light trade, are thorite, orangite, and monazite. all of which contain both thorium and cerium. Others which are used are fergusonite, cerite, euxenite, columbite, etc.

Monazite has a color varying from brownish yellow to yellow, thorite and orangite hovering between brownish yellow and orange. Most of the others are as black as pitch, opaque, and of a greasy lustre. The chief source of the three minerals was till lately southern Norway, in the neighborhood of the Langesund fjord, where they occur on the southwestern shore in veins of pegmatite, where they are associated with the red orthoclase which forms most of the vein. The felspar is exploited for porcelain making.

When the incandescent light caught on, in 1893, the price of minerals containing thorium naturally went up

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enormously. Then a certain common mineral acquired, through a defective analysis, the reputation of containing thorium, and German agents bought up as much as they could get hold of at big prices. Poor people suddenly became rich, and a thorite fever raged in Norway. Everybody went out and hammered away at the rocks. Women sold the weighting stones of their mangles for large sums, stones were torn out of the walls of buildings, and nobody talked about anything but thorite. In time, however, an accurate knowledge arose of what minerals contained thorite and what did not. So far, Norway has only yielded between one and two tons of thorite and thorite containing minerals.

The price of thorite has been £25 per kilogramme, of orangite £30, and of monazite 30s. for the same weight, but, in spite of the great demand, the price of thorite fell to £4 per kilogramme, because the slender yield of Norway was supplemented by that of other places. In America considerable deposits of monazite sand have been found, and are now used for the preparation of thoria and ceria. In the State of Carolina there are hundreds of square miles of this deposit, averaging 18in. thick, but 13ft. in places. The thorium containing part of the sand averages about two per cent. of the whole, but 60 or even 85 per cent. of it has occasionally yielded thoria.

Unfortunately, monazite contains much more cerium than thorium, and the mantles have to contain more thoria than ceria. Very lately large deposits of monazite sand have been found in Brazil, and the necessary substances for mantle making are now made in large quantities, and works have been established for the purpose in Saxony at Glanchau, Oderan, and Duben. Minerals containing thorium and cerium have been discovered in some Russian, Canadian, and Australian rivers, and minute quantities of them occur in many parts of Germany.

CONSTRUCTION OF THE UNDERGROUND TROLLEYS IN SIXTH AND EIGHTH AVENUES.

Passengers on the Sixth and Eighth avenue street railroads were startled yesterday by seeing an announcement in bold, black type that the work of constructing the underground trolley would be begun next Wednesday. It was welcome intelligence to the travelling public, and especially to the Sixth and Eighth avenue merchants, who have been complaining that trade has been slipping away from them on account of the inadequate transit facilities afforded by the Metropolitan Street Railway in two of the principal thoroughfares of the city. They saw the promised land of real street cars before them, and they did not forget that the "Herald" had done much to make it visible.

Street car horses will be cheap, for pending construction no cars will be run. This will cause the travelling public some inconvenience, but they are disposed to bear present afflictions meekly in view of the relief which they see at hand. Besides, many of them would prefer walking to being jolted and rocked in the vehicles which have been in use. The cars seemed to grow a little more rickety with each year.

Many criticisms have been made of the policy of the Metropolitan Street Railway Company in delaying the work so long. The company has, however, had the iron work for both roads on hand for several months.

Contracts for the construction were let last Saturday. Contractors are now busy assembling their workmen and providing them with the necessary tools. Officials of the company are confident that the two roads will be in operation by September 15th. There have been heartburnings and jealousies on the part of the merchants of Sixth and Eighth avenues for fear that the other avenue would be first in the vanguard of progress. The company therefore promised that the two thoroughfares should be improved simultaneously.

It is expected that no extraordinary difficulties will be encountered. The work of constructing the Madison avenue electric line was delayed by the necessity of displacing sewer and other pipes. In Sixth and Eighth avenues there are no such impediments in the way. All that has to be done is to dig the trenches and place conduits and wires.

In the interest of the convenience of the travelling public the Metropolitan Street Railway Company gives notice that, although the horse cars on the Sixth and Eighth avenue routes will be discontinued on Wednesday morning, the passengers who ordinarily use them will have special facilities on its other roads. The electric railway which runs in Amsterdam and Columbus avenues now crosses the city by way of Fifty-ninth street. Beginning on Wednesday next, the electric railway in Eighth avenue north of Fifty-ninth street will also run across town, and transfers will be made from both these lines to the Broadway cable line at Seventh avenue, the Madison avenue electric line, the Lexington avenue cable line and the Second avenue electric line. For travellers west of Broadway additional facilities will be provided on the routes of the Seventh and Ninth avenue horse car railroads.

SOME PHASES OF THE RAPID TRANSIT PROBLEM.*

BY ALBERT H. ARMSTRONG.

(Continued from page 39.)

Another method would be to accelerate at a constant rate until maximum speed is reached, then continue this speed constant by supplying motors with just sufficient power to overcome train friction. This latter method of train acceleration, however, demands such a considerable increase in the amount of energy required for the run that it has not hitherto been considered.

The three methods of acceleration are illustrated in Fig. 5, showing the three forms of speed curves, a—a accelerating at a constant rate and coasting after maximum speed is reached until brakes are applied; b—b, accelerating at a constant rate and continuing at full maximum speed until brakes are applied, and c—c accelerating at a constant rate until starting resistance is cut out and further acceleration allowed to continne at a constantly decreasing rate with constant full line potential at motor terminals until maximum speed is reached, when train coasts until brakes are applied.

Curve a—a reaches the highest maximum speed but wastes the least energy in the brakes, and hence is the most efficient run mechanically, curve b—b, the constant-speed method, being the least efficient.

As these three curves were plotted from the speed-torque curves of an actual motor, it is instructive to compare the watt hours consumed for each run with series-parallel control, operating two motors in series, then in multiple. To this end a set of energy input curves have been plotted in Fig. 5, showing that curve c—c requires the least maximum energy input, while curve a—a requires the greatest amount.

The area enclosed by the energy time curves is a measure of the average energy consumption for each run, and their respective values reduced to watt hours are:

a. Constant current and coasting, 147 watt hours per ton.

b. Constant current and no coasting, 160 watts per ton.

c. Constant current and acceleration on motor curve, 126 watt hours per ton.

Hence, of the three methods, curve c, making use of the acceleration due to a series motive curve, not only

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requires the least maximum current input, but also requires the least average energy input to the motors for a given run, and hence is the form of curve used in the majority of actual runs. Although the energy given out by the motors in run c is greater than in run a, as evidenced by the higher speed at which brakes are applied, yet this extra work is done so much more efficiently, owing to the smaller starting loss, that the total watt hours input becomes less.

It will be noted that all curves of Fig. 4 approach a minimum value of thirty watt hours per mile; that is, the minimum energy expressed in watt hours per ton mile for a given run will be double the friction rate. The actual factor is 1.98 and forms a very convenient method of determining the net energy consumption for any speed and train weight if the friction rate be known. Thus, assuming the light load efficiency of a railway motor, including gear loss, to be 75 per cent., a friction rate of 15 lbs. per ton would demand an input of 40 watt hours per ton mile, corresponding to an input of 1,200 watts per ton weight of train, at, say, a constant speed of 30 miles per hour.

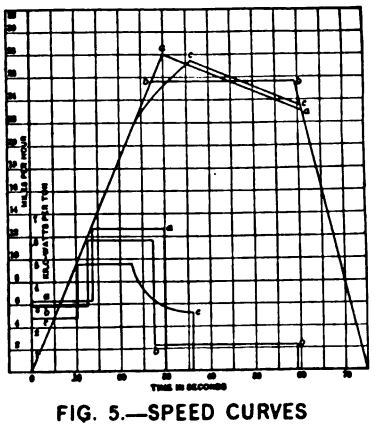

FIG. 5.—SPEED CURVES

Distance, 2000 ft. Time, 75 seconds. Friction, 15 lbs. per ton. Braking effort. 150 lbs. per ton.

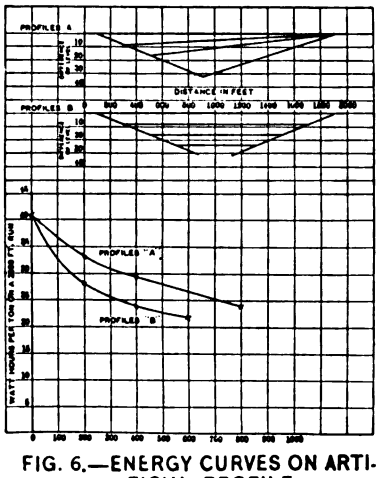

FIG. 6.—ENERGY CURVES ON ARTIFICIAL PROFILE

A number of interesting conclusions may be made from the foregoing investigation of the operation of trains upon a level track.

1. The rate of acceleration determines the energy consumption for a given run, and since this energy consumption decreases with increased rate of acceleration, the train should be brought up to speed as quickly as possible and allowed to coast to secure the minimum energy input.

2. The maximum current input during acceleration increases with the rate of acceleration, and hence limits the rate at which a train can be accelerated with a given feeder loss or feeder investment.

3. In order to reduce the average energy consumption and also the maximum current input to a minimum for a given run, a due amount of acceleration should take place on the motor curve after starting resistance is cut out; hence a motor should be carefully proportioned for the work it has to do.

4. A normal amount of coasting should be permitted after power is shut off, partly to provide a margin to allow for errors of judgment of the motorman, but largely because this is the most efficient method of accelerating a train. On no account should the maximum speed be continued by supplying the motors with just sufficient current to overcome train friction, as this method of accelerating is very wasteful and inefficient.

Having discussed various methods of accelerating, it is interesting to follow out the problem and determine the actual efficiency of transporting passengers by our modern methods of travel. It has been pointed out that only from 15 to 20 per cent. of a fully loaded train consists of a paying load, and with an average load as carried throughout the day this percentage will be reduced to 10 per cent. or less; that is, nine-tenths of the energy consumed in moving this train at a constant speed is wasted. But in rapid transit work a train seldom attains a constant speed, due to the frequent stops and high schedule speed, and at least ten times the energy required to overcome friction alone must be expended in accelerating the train, only to appear as heat in the brake shoes when bringing the trains to rest. That is, considering the friction work of the train as the only useful work done, an efficiency of only 10 per cent is reached in the average run. But only 10 per cent of this friction work is useful in moving passengers; hence the actual passenger efficiency is reduced to less than 1 per cent. of the total energy delivered to the train during acceleration.

When it is considered that further losses occur in operation in the motors and their method of control, in the transmission lines and generators of an electric traction system, it will be appreciated that the present method of transportation, with its efficiency of a fraction of 1 per cent., opens a wide field for improvement. This applies with greater force to rapid transit service using steam locomotives as a motive power, as the dead weight carried per passenger is greater with a steam locomotive than with a motor car, and the efficiency from the coal pile is much less. Hence some means of reducing the large loss due to accelerating the train is desirable, and this is found in the adoption of an artificial profile, as followed out in a large underground road now building, using down grades in starting and up-grades to retard the train when stopping.

The ideal profile would provide for a down-grade at starting sufficient to do the work of acceleration and with an up-grade to do the entire braking required, thus leaving only the friction energy to be supplied by the motive power. Such a road would operate at 100 per cent. efficiency, neglecting the dead weight of train carried and considering total friction work as useful work.

Reduced to practice, this ideal grade must be modified considerably. The per cent. grade used is limited partly by the rapidity of acceleration that may be imparted to the train without discomfort to the passengers, and partly by the available tractive effort of the motive power, which must be sufficient to haul the train up the grade in case of necessity.

(To be continued.)

Harriman, Tenn.—D. W. Thomas, city clerk, may give information concerning construction of an incandescent-light plant.

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ELECTRIC TRACTION.

NOTES ON THE APPLICATION OF ELECTRIC MOTIVE POWER TO RAILWAY SERVICE, WITH ILLUSTRATIONS FROM THE PRACTICE OF THE METROPOLITAN ELEVATED ROAD OF CHICAGO.

BY M. H. GERRY, JR.

(Concluded from page 36.)

The speed of a series railway motor at any given impressed E.M.F. is fixed by the total resistance of the train. The horizontal effort developed must just equal the resistance, or the velocity will change; therefore, if it be desired to maintain a constant speed, or to vary the velocity in any manner not corresponding to the fixed relations of speed and torque for the particular motor and voltage, it will be necessary to alter the impressed E.M.F., or to commutate the fields. To obtain this variable E.M.F. at the motor terminals from the constant E.M.F. of the line, many arrangements have been proposed, but only two are in use to any extent. They are by rheostat in the main circuit, and by grouping two or more motors in series and parallel combinations. Practically, the two methods are combined and are now in nearly general use. The rheostatic method wastes the energy represented by the reduction in voltage, and the series-parallel arrangement provides two or more voltages at the motors without preliminary loss. The controllers in use on the Metropolitan are two combination series-parallel and have three steps on the rheostat for each voltage. The losses in this apparatus vary from 10 to 20 per cent., depending upon the skill with which it is handled. With care this can be kept down to 10 per cent., making no allowance for the reduced efficiency of the motors at the lower voltages. The series-parallel system has decided advantages over all other methods thus far tried in practice, but it lacks flexibility and ultimately may not prove to be the best for heavy railway work and especially for high speed service.

No. of trip	1	2	3	4	5	6	7	8
No. of cars in train	4	4	4	3	3	2	2	4
Total time of trip	28'26"	29'03"	28'30"	28'37"	27'26"	25'30"	23'48"	32'44"
Total time of stops	2–19	2–05	2–42	1–47	1–16	0–54	1–22	1–41
Time running	26–07	26–58	25–58	26–50	26–10	24–36	22–26	31–03
Average speed (including stops)	13.3	13.0	13.2	13.88	14.4	14.9	15.9	11.53
Average speed (not includ. stops)	14.4	14.0	14.5	14.7	15.1	15.3	16.8	12.2
Average current (including stops)	138.3	142.6	138.6	130.2	129.5	90.1	106.6	101.1
Average current (not includ. stops)	148.7	153.2	151.8	137.4	135.6	92.5	112.4	106.4
Average volts (at the train)	504	498	503	512	516	521	529	509
Efficiency from generators to car axles	51	50.5	52	50	51	51.5	50	47.5
Kilowatt hours per car mile (at the train)	1.32	1.36	1.32	1.69	1.62	1.58	1.76	1.11
Kilowatt hours per car mile (at the station)	1.44	1.52	1.44	1.81	1.68	1.67	1.69	1.21

The selection of the proper motors and controlling apparatus for a given service deserves more attention than it has generally received. The horse-power and maximum speed have too often been the determining quantities. A rating based on horse-power is now understood to be of little value, and the maximum speed of which a motor is capable may be of still less account as representing its performance with a train. Quite generally, motors have been speeded too high, the result being insufficient starting torque, a poor commercial efficiency and less average speed than a better selected motor would have developed.

The Generators and Feeder.

Anything like a complete discussion of modern railway generators or of the problems connected with railway feeders, might well be the subject of a separate paper. It is designed here simply to touch upon a few points relating to the general system.

Railway generators at the present time are nearly all of a direct current type, but there is reason to believe that in the future two and three-phase alternating current machines will be installed. The development of the rotary transformer will be largely responsible for this change in practice. Power stations can be more favorably located in respect to fuel and water supply, and through sub-stations furnish power to larger areas. With this change will come also greater economy in the production of power, which cannot but have a favorable effect on the development of the electric railway.

The commercial efficiency of railway generators varies from 90 to 95 per cent. Under favorable conditions, the average or "all day" loss for large direct-connect d machinery (units of over 600 K.W.) is about seven per cent. Direct-connected alternating current generators give about the same efficiency as direct current generators. Commercially, the best results are obtained with a few units of large size. It is unnecessary and poor practice to install many small units for railway work.

The load line of an electric railway is subject to two kinds of fluctuations; first, those sudden changes caused by the starting together of a number of trains, and secondly, the more gradual change due to the variation of traffic at different hours of the day. On roads operating but few cars, the fluctuations due to the first cause are of considerable amount, but on large systems with many cars the changes in loading from starting up of trains are very slight—hardly noticeable, in fact—and this is especially the case if the feeders are tied together and form a network. There still exists, however, the change in the load line corresponding with the traffic. A railway load line differs from that of a lighting station in having two nearly equal "peaks" or points of maxima, one in the morning and one in the evening. These variations are best taken care of by cutting in and out units, while the momentary changes can usually be cared for by a slight overloading of the machinery. Engines and generators for railway purposes have a good efficiency over quite a wide range and generally stand overloads very well. In Fig. 12 are shown seven load curves from the power station of the Metropolitan Elevated. The curves correspond to the days of the week and indicate the average power taken, but do not show momentary fluctuations, caused by the movement of trains. The chief characteristics of these curves are the two decided "peaks" occuring daily with great regularity. The peaks vary as to amouut and time, with the season of the year, and to some extent with the weather, but are always present in a marked degree. Street railway systems with many lines extending to different parts of a

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city, usually show a station load with less decided and broader peaks. This is due in part to the habits and occupations of the patrons of the various lines which determine the hours of maximum traffic. When combined, the load curves from a number of such lines will give a more favorable station load than any one line or group of lines in the same section of a city.

The load curves of the Metropolitan have proven to be a very sensitive index of the traffic. A delay on the competing cable lines or increase of travel from any cause is at once noticeable in the power house. The greater station loading is due not so much to the increased weight in passengers carried, as to the longer stops necessary to discharge and to take on passengers; thus requiring a higher speed to keep the trains on time.

The feeder system has an effect upon the form of load curves as well as upon the total amount of energy required. The highest percentage of loss will occur at the moment of greatest loading, but this rarely takes place at the same time on different sections, and an advantage is obtained by connecting the lines together to form a net work as far as possible. Feeders are usually divided into sections as a matter of safety and convenience. The best economy of copper and of power, and the most favorable road lines are obtained when the number of such sections are as few as consistent with the safety and flexibility of the system. When feeder sections are connected, the best practice calls for a fuse or circuit breaker in this circuit. The permissible percentage of loss between the power house and the trains is partly a commercial question, depending on the cost of power and interest on the feeder investment. Transformers, rotary converters, boosters, batteries, and similar apparatus forming a part of the feeder system, should be considered with special reference to cost, operating expense, all day efficiency and effect on the load factor of the generating station.

The Efficiency of Transmission.

The energy dissipated between the engine and the car axles may be divided into three parts, that lost in the electrical generators, the losses in the transmission lines (including transformers, rotaries, etc.) and the losses in the car controlling apparatus and motors.

The amount of loss in the generators will depend upon their efficiency and average loading. Modern railway generators have good efficiency above half load, and in stations designed with reference to the load line, there is but little difficulty in keeping the machinery above three-quarters at all times. In the table below are given the efficiencies for a number of direct-connected machines of modern design.

Type of Machine.	Commercial Efficiency.			
	Full load.	¾ load.	½ load.	¼ load.
D. C. Generator, 700 K.W.....	94	93	92	—
D. C. Generator, 750 K.W.....	93.5	92.5	91	85
D. C. Generator, 800 K.W.....	96	95	92	—
D. C. Generator, 1,500 K.W.....	94.5	94	93	—
A. C. Generator, 750 K.W.....	94	93	91	—
A. C. Generator, 600 K.W.....	93.5	92	87	82
A. C. Generator, 700 K.W.....	94	92	90	88
A. C. Generator, 650 K.W.....	93.5	91.5	89.5	—
Rotary transformer, 650 K.W.....	94	92	90	—
Rotary transformer, 600 K.W.....	95.5	92.5	90	84

With machines of this type and size, the all day efficiency ought to be about 92 per cent. A sub-station provided with rotaries and static transformers working under a good average loading, should have an efficiency of about 89 per cent.; a loss of 8 per cent. in the rotaries and 3 per cent. in the transformers. The sub-station apparatus is at its highest efficiency at the time of greatest loading, when the feeder lines are at the lowest efficiency and thus have a favorable effect on the load line.

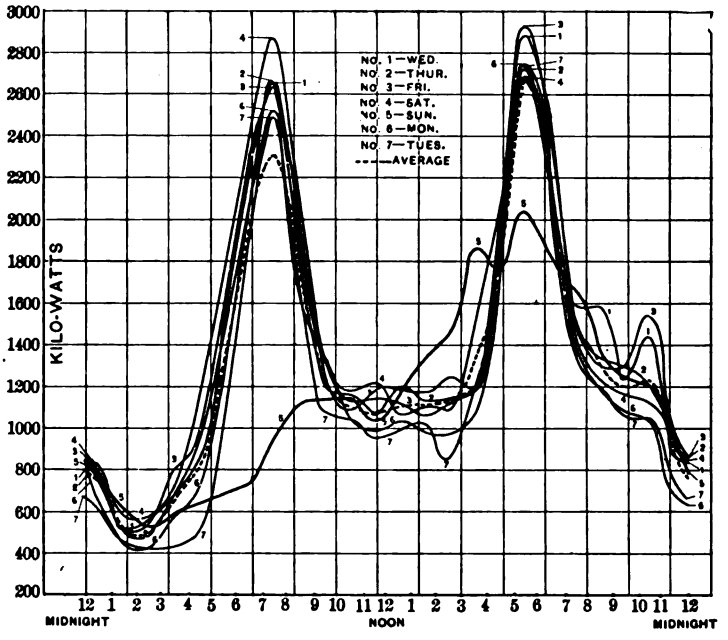

Fig. 12.

The losses on railway feeders vary from 10 to 25 per cent. Often there is sufficient copper if rightly distributed and tied together to reduce this at least one-half. Such a change would also improve the load factor and increase the efficiency of the station. The losses in the motors and car apparatus have already been referred to in this paper, but actual data and tests are here introduced in evidence.

From a large number of tests made on the trains of the Metropolitan Elevated Road, the following have been selected as illustrating this part of the subject. The trips are numbered from one to eight, and in the table below the data for each trip are given, together with the general results obtained. All of these runs were made on a dry track, in moderate weather and under average working conditions. The total electrical energy at the train was measured by Thomson recording wattmeters and the voltage and current by Weston instruments. The velocity record was taken from a Boyer speed recorder and the stops and average speed from a double set of stop-watches. The pressure at the station was measured by a recording voltmeter.

Trip No. 1 was made from Franklin street over the Logan Square line with a four-car train, heavily loaded, making an average running time of 13.27 miles per hour.

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THE INCREASED CONSUMPTION OF COAL BY ELECTRIC LIGHT PLANTS.

The rapid consumption of coal in America and Europe has caused some concern to those interested in matters of vital importance to the human race. The dependence which we place upon our coal mines has become so great in the past fifty years that if the supply should suddenly cease the wheels of commerce would stop, and the civilized races, horrified at the prospect of eternal labor, would be plunged into unutterable grief. The coal fields of Great Britain may not last more than a century. Her miners are already burrowing under the ocean's bed for the precious fuel. The mines in India and South Africa, upon which her future hopes are founded, are undeveloped. Germany, France, Italy, and even Russia, have little or no coal to spare. The United States stands alone in the possession of vast coal fields of seemingly unlimited extent.

The great electrical industries have had a great deal to do with the enormous annual consumption of coal now going on. An authentic report on the mineral industries of this country shows that New York city in 1897 consumed 1,850,000 tons of bituminous coal and 3,300,000 tons of anthracite. The city of Philadelphia in the same year used 3,190,000 tons of anthracite and 920,000 tons of bituminous. Other large, well known cities used the following enormous quantities: Chicago, 1,420,000 tons of anthracite and 3,220,000 tons of bituminous; Brooklyn, 1,800,000 tons of anthracite and 200,000 tons of bituminous; and, finally, Boston, 1,240,000 tons of anthracite and 525,000 tons of bituminous. It is, of course, understood that a percentage of this coal is used by the various manufacturing concerns of the above-mentioned cities, but a very heavy percentage of it is burned by electric light, power and street railway companies.

In the mining of coal, from one-third to one-half is wasted. Every ton transported represents from a ton and a half to two tons that has been mined, but through waste and other losses the available amount is comparatively small. Fuel consumption in our large cities and in the smaller towns is increasing year by year. The millions of tons of coal annually consumed will grow and multiply enormously in the next twenty years. Any method of consequence devised for the purpose of aiding the economical consumption of coal will add largely to the future happiness of this race by setting further away the date of its final consumption. Fortunately the ingenuity of the Yankee mind has brought into being innumerable devices of a coal-saving nature, which certainly reduce the annnal consumption to figures much less than they would be were their application not appreciated.

The ownership of coal is the ownership of power. Modern warfare has shown that coal is the open sesame to all ports. Gold is the symbol of power, but the power itself, the actual force and strength of nations on the high seas and on land, is coal.

The electric light and motor, the great iron foundries and factories, are chewing up coal, as we see, at the rate of millions of tons a year. It cannot last forever, and our only hope is that some new genius will arise and show us how to wrest a small quota of energy from the infinite storehouse of nature.

X RAYS FOR TESTING COAL.

The Paris Academie des Sciences received a communication from M. H. Couriot regarding the application of X rays to coal. M. Couriot believes in testing coal for the purpose of showing its salicious formation. The test of the different grades of coal by this means is a remarkable one, the slag and clinker forming elements appearing upon the screen quite distinctly. M. Couriot has tested anthracite, lignite, coke, peat and block fuel in this manner. Almost invisible specks of silicate appear on the screen and traces of other impurities. It is curious to see the particles of iron sulphide in coke and the conglomerate formation of block fuel.

Coal is absolutely transparent to the X rays. Photographs taken by M. Couriot merely show a rude outline of the lump under inspection, with a variety of specks and streaks passing through the piece in all directions. The roughest chunks are just as serviceable in this test as though carefully hewn into shape, but the main object and value of this method in indicating the presence of impurities should lead to its universal adoption by all large and progressive coal dealers.

THE RATIO OF HUMAN PROGRESS.

At the last meeting of the British Association, Mr. George Iles read a suggestive paper, "Why Human Progress is by Leaps." He points out that the triumphs of man over nature in the discovery of its laws of action are not simple additions to his resources, but are multipliers of high potency, often extending over the whole field of his activity. This he illustrates by the manifold applications of electricity in our own day, and by the use of fire in prehistoric times. He draws the conclusion that man's advance will in the future be at a continually accelerated pace.

This reasoning is closely akin to that of Lewis H. Morgan in the chapter on the rate of human progress in his "Ancient Society," New York, 1878. He there argues that culture-progress proceeds by geometrical, not arithmetical ratios; which is substantially Mr. Iles' position.

It should be borne in mind, however, that true culture cannot be measured by criteria drawn solely from the utilitarian arts. Civilization has been nicely defined by a French writer as a "state of mind," rather than a schedule of possessions; and this is singularly true.—Science.

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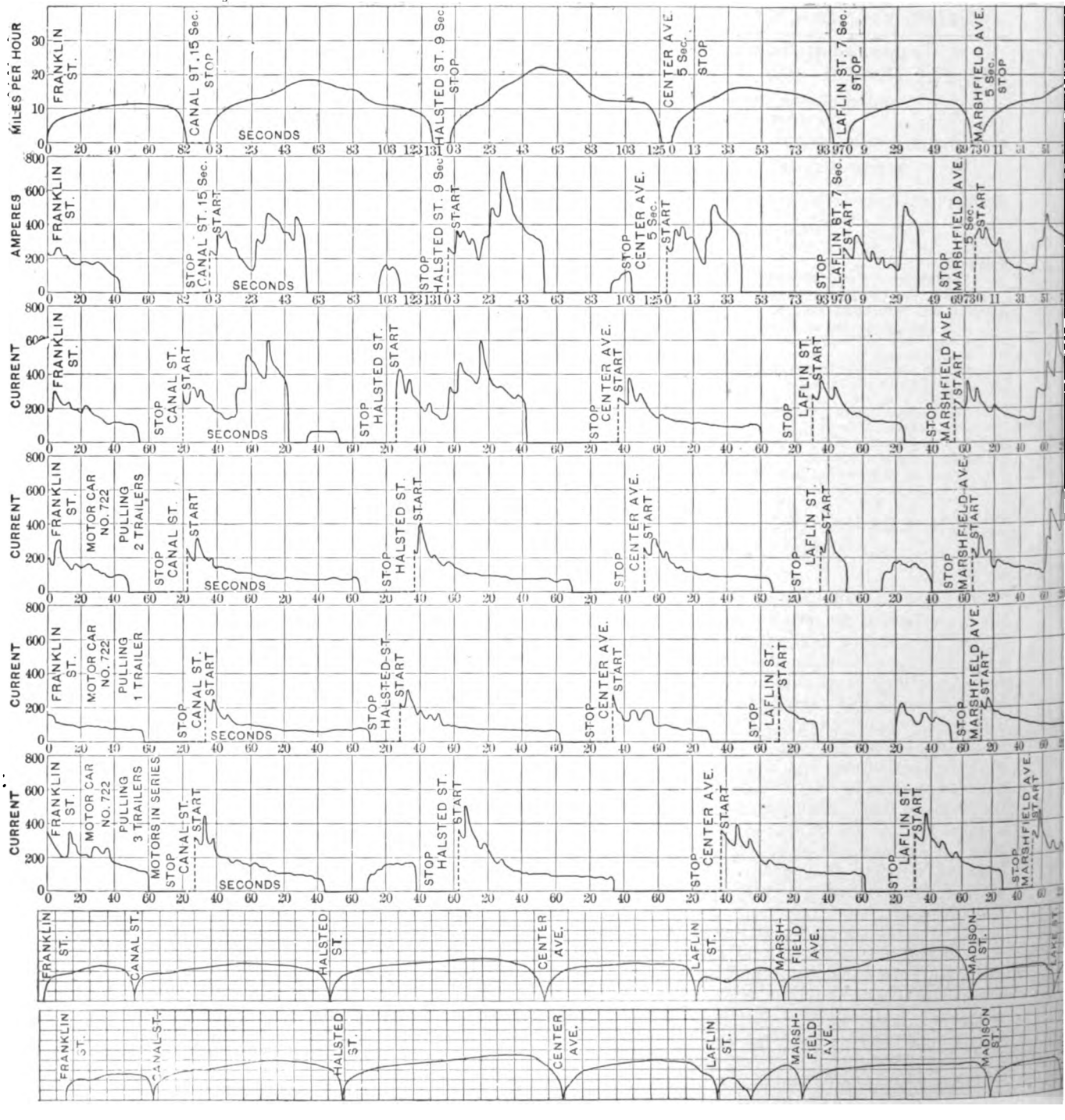
The maximum grade on this line, going west, is 0.75 per cent. ascending for about 2,350 feet, and descending for about 1,950 feet. Other grades do not exceed 0.03 per cent. and only extend short distances. Current and speed diagrams on a time basis are plotted in Fig. 13 for trip No. 1. The current is the total amount taken by the train for power, and an inspection of the diagram will readily show the point of passing from series to multiple. The amount of energy required or absorbed by the train is as follows:

Average volts at train	504.
Average watts at train	6,9678.
Electrical horse-power transmitted to the train	93.4.
Average volts at the station	545.
Average watts at the station	75,346.
Electrical horse-power at the station	101.
Efficiency from electrical generators to car axles	51 %.

Assuming the commercial efficiency of the generators as 93 per cent., the total power required at the engine shaft to propel this train is 108.5 horse power.

Trip number 2 was made with a four-car train, under



Total energy for accelerating the train	30,940,000 ft. lbs.
Total energy for train resistance	14,110,000 ft. lbs.
Total energy for grade	3,400,000 ft. lbs.
Total energy required for propelling the train	48,450,000 ft. lbs.
Per cent. of energy for accelerating	63.9.
Per cent. of energy for train resistance	29.1.
Per cent. of energy for grade	7.0.
Time of trip, including stops	28 min. 26 sec.
Average H. P. required for propelling train	51.5.
Average amperes of current	138.25.

similar conditions to trip number 1. A current curve on a time basis is given for this trip in Fig. 14. In all of the current curves, it is easy to distinguish by inspection when the motors are in series and when in multiple. The stops on the controlled are also distinguished by the greater peaks on the curves. The smaller peaks and other irregularities are due, principally, to changes in voltage, caused by other trains in the same section taking more or less current.

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Trip No. 3 was made under similar conditions to trips 1 and 2, and the data and results are given in the table.

Trip No. 4 and 5 were made with heavily loaded three-car trains and the results are set forth in the table. Both the speed and commercial efficiency of apparatus are higher than in the case of the four-car trains. A diagram of current on a time basis for trip No. 4 is given in Fig. 15, and a speed curve on a distance basis in Fig. 18.

Trips No. 6 and 7 are with two-car trains and show a higher speed than attained in the case of the three and four-car trains. The greater amount of power consumed in trip 7 is due, mainly, to the increased speed over trip 6. A current curve for the latter trip is shown in Fig. 16, and a speed curve in Fig. 17.

Trip No. 8 was made with four loaded cars and the motors operating only in series. Both the speed and current are less than for similar trips with the motors operating in series and multiple. The percentage of power saved is greater than that of the reduction in speed, but this is due, not to a better efficiency of the apparatus at lower speeds, but to the fact that the amount of power required to propel a train making many stops decreases more rapidly than the average speed. The current diagram for the trip is given in Fig. 17.

The amount of power lost in the machinery and line, as indicated by the commercial efficiency of the apparatus given in the table, might seem at first thought to be large, but considering the transformation and the distance of transmission, it is certainly not excessive. The loss in this respect is offset by the smaller cost of producing energy by power-house methods. The train weight also may be reduced with electric power to a point impossible with steam locomotives, and the rate of acceleration increased, and thus a saving effected in power used at the train. While this does not improve the efficiency of the transmission, it reduces the total amount of power required, and as a feature of the system it should be given due credit.

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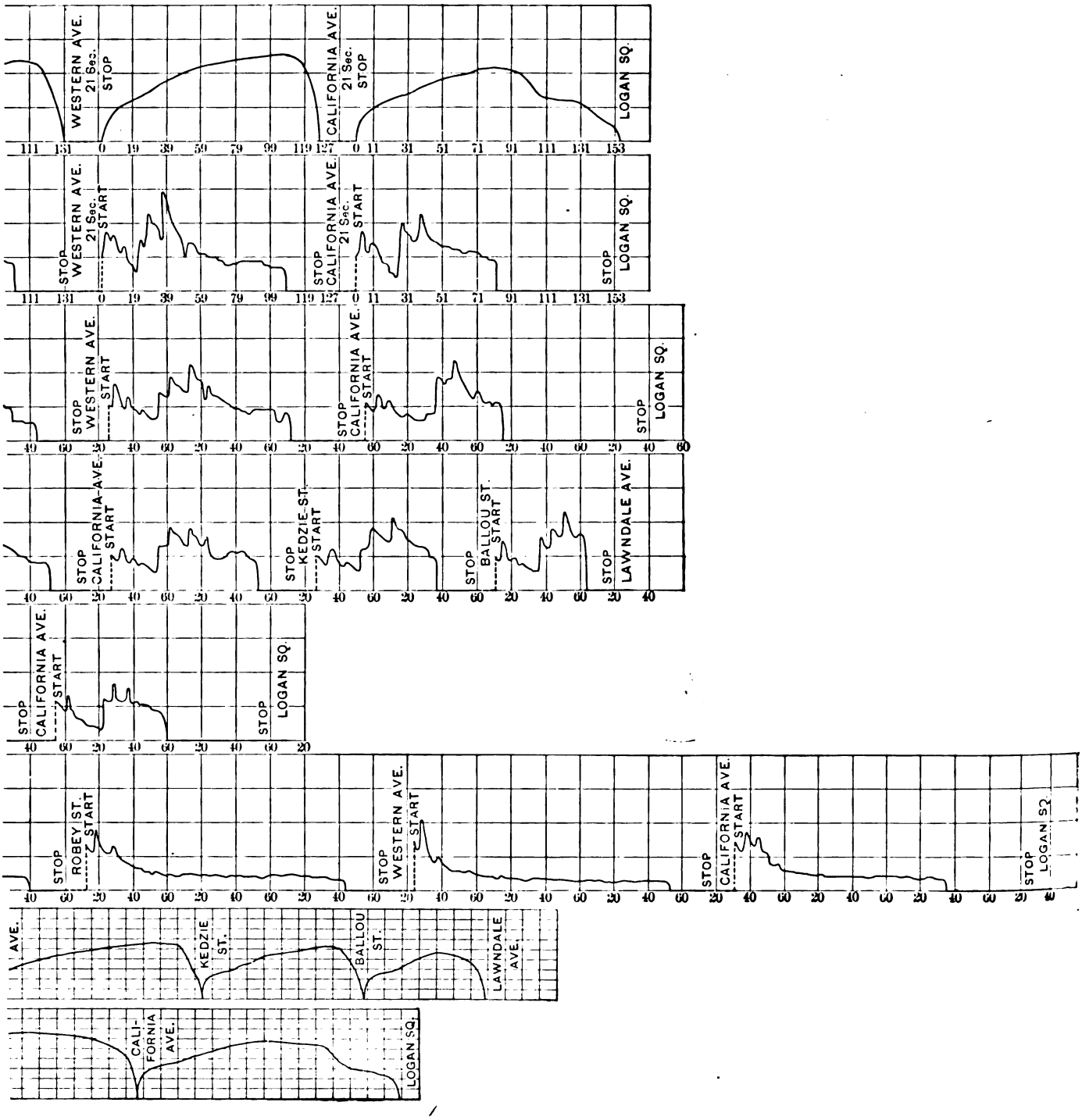
Electrical energy can be produced in the vicinity of Chicago, with cheap coal, under the conditions of a railroad load, at less than half-a-cent per kilowatt-hour, and in the form of mechanical energy at the car axles, costing about one-cent per kilowatt-hour, it is several per cent. cheaper than it can be generated by steam locomotives. Add to this the actual saving in energy from a more rapid acceleration and from reduced train weight, and the total direct advantage for the electrical system is obtained as far as economy in power is concerned.

NEW YORK ELECTRICAL SOCIETY.

The following members of the New York Electrical Society who have changed their residence are requested to send their new address to the Secretary, 120 Liberty street, New York City:

B. F. Sherman,
R. S. Dobbie,
D. D. Book,
H. Van Sands,
L. J. O'Reilly,
A. V. Waldron,
Harry Cette,
C. A. Thompson,



While any reduction in the cost of power (not only for fuel, but repairs, labor, water, oil and waste, etc.) is of great importance to railroads, the many other advantages of electricity, representing betterments of the service and greater earning capacity are the chief qualities which will determine its adoption in any case in place of steam locomotives. As a motive power electricity is simple, efficient and wonderfully flexible, and it is hardly wise to predict its limitations.

Fred Reed,
C. W. Raymond,
W. F. Collins,
C. E. Hart,
J. Egan,
G. C. Webb,
D. H. Washburn,
J. C. Harris,
W. Schwein,
E. E. Stark,
J. T. Palmer,
T. F. Grover,
J. C. Henry,
J. W. Doyle,
R. A. Varley,
C. H. Wright,
C. C. Gartland,
John Deane, Jr.,

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Thos. Bennett,
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S. S. Harris,
C. E. Chinnock,
R. Crawford,
A. C. Greenburg,
B. F. Card,
A. B. Bennett,
N. Hall,
J. D. Underhill,
J. A. Cabot,
W. E. Lamb,
E. Denning,

F. E. Dolbier,
C. A. G. Groenbeck,
Jas. Stewart,
C. F. Green,
M. W. Grovesteen,
G Arnold,
J. S. Cobb,
D. H. Starralt,
E. Voelckel,
G. R. Shepard,
W. L. Tamblyn,
A. Stamm,
C. J. Bickley,
H. B. Niles,
J. McMahon,
E. S. Reid,
J. H. Longstreet,

Application of the Multiphase

R. A. Mitchell,
R. Leichman,
H. A. Dingle,
C. Herman,
Leo Bock, Jr.,
H. F. Salamons,
A. G. Holcombe,

M. B. Meddler,
C. P. Gott,
A. C. Barrett,
A. W. Steiger,
E. C. Miller,
A. McKinnon,

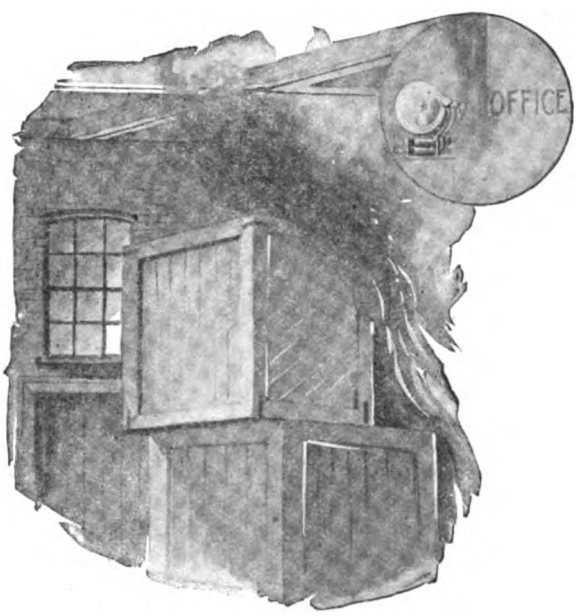
J. JONES & SON report the receipt of a large foreign order for goods of their manufacture, which will keep their factory busy for some weeks.

Rossland, B. C.—The "Miner" states that a new project is on foot to supply the mines with electric power. The promoters propose installing dynamos at the Kootenay Hydraulic Mining Company's plant on the Pend d'Oreille, back of Waneta, and transmitting electricity to Rossland, a distance of 17 miles. At the outset the plant will have a capacity of 750 horse-power, but will be so constructed to permit of greatly increasing this power. About $170,000 has been subscribed towards the enterprise, and there are still some 200,000 shares of stock yet in hand. Orson D. Archer & Son, of New York, are the eastern representatives of the project.

PROTECTION OF BUILDINGS FROM FIRE.

The efficiency of the multiphase cable has been tried on many occasions in a most satisfactory manner. According to the "Insurance Press" the Suburban Underwriters' Association, on June 28th, 1898, increased the rebate allowed for the auxiliary fire-alarm system to ten per cent. when the boxes are connected by multiphase wire. The underwriters are never better pleased than when they discover the fire-alarm system installed in a building to be automatic and reliable. The reliability of many contrivances used for the purpose of bringing an alarm has been doubted in many cases, but a change of opinion has taken place in favor of the multiphase cable, manufactured by the Montauk Multiphase Cable Company, of 100 Broadway, New York City.

Our readers are probably well acquainted with the virtues of this cable, particularly those that visited the Electrical Exhibition at Madison Square Garden, at which the above company showed by practical experiments the superior value of their cable and its method of application. It seems as though further argument is totally unnecessary when the authorities on the subject of fires, the underwriters themselves, fully believe in the advantages of the Montauk system.



Cable in the Home and Factory.

The multiphase cable used in connection with the auxiliary system really places a house under surveillance of the most constant nature. It is practically impossible for an undue rise of temperature to occur in any portion of the building without operating an alarm. In those rooms most susceptible to the influence of fire, auxiliary boxes placed in each of them connected by wires, as shown in illustration, would operate instantaneously at the appearance of fire at any point. The alarm is immediately sent to headquarters the instant flame touches the wires, assistance proceeding from this centre to the building requiring assistance. By a combination of the multiphase cable and the Gamewell auxiliary system a building practically looks out for itself as though endowed with intelligence, ringing its own alarm, giving its number and location and calling for aid as loudly and emphatically as though animate with conscious life.

The "Insurance Press" mentions in an article called "A Great Advance in Fire-Alarm Telegraph Protection" that "the managers of the auxiliary automatic alarm do not intend to come into competition with the established thermostatic central offices, but in furnishing automatic alarm facilities in the vastly larger territory in which the

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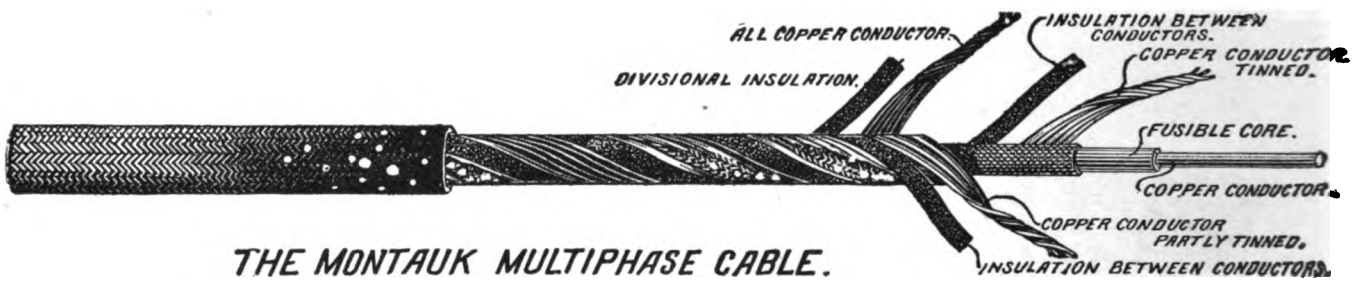
central office systems for reasons stated have never operated they will inaugurate a new era of improvement in fire-alarm telegraph facilities which will doubtless be as readily welcomed by all fire underwriters as it has been by the Suburban Underwriters' Association."

The illustrations in this article show the cable dissected, a factory room beginning to blaze, and the hotel indicator system. The general application of this system for suburbanites is invaluable in its wonderful protective power and immediate aid to those in want of assistance.

THE LIQUEFACTION OF HYDROGEN.

Fuller particulars regarding the liquefaction of hydrogen and helium by Professor Dewar have come to hand in his paper in the *Proceedings* of the Chemical Society.

In seconding a vote of thanks to Professor Dewar, moved by Sir William Crookes, Dr. Armstrong called attention to the fact that in the earlier days of the Chemical Society much attention had been given to the discussion of the properties of hydrogen, and the view that it possessed metallic properties had been strongly advocated. This was strongly supported by Graham's investigations of hydrogenized palladium, or, hydrogenium, as Graham called it, condensed on palladium. Dr. Armstrong, ventured to think, however, that the subject had been too much regarded from the inorganic side, and that when the evidence to be derived from organic chemistry is taken into account it is more probable that hydrogen will be found to resemble the petroleum hydrocarbons rather than the metals. In reply to a query from Dr. Armstrong, Professor Dewar said that, since Argon solidifies when cooled in liquid air, his experiment with helium shows that the



THE MONTAUK MULTIPHASE CABLE.

SHOWING FUSING EFFECT AFTER CONTACT WITH DANGEROUS HEAT OR FLAME.

As early as 1895 Dewar had constructed an apparatus by which he could produce a jet of hydrogen containing liquid. It was then shown that such a jet could be used to cool substances below the temperature which could be reached by the use of liquid air. A much larger apparatus of the same type was then constructed, in which the liquid-air plant was combined in its circuits and arrangements for the liquefaction of hydrogen. The construction of this apparatus consumed a year, and many months were occupied in preliminary trials and tests. On May 10th hydrogen was liquefied by allowing the gas, cooled to—205°, and under a pressure of 180 atmospheres, to escape continuously, at the rate of ten to fifteen cubic feet per minute, from the nozzle of a coil of pipe in a double silvered vacuum vessel of special construction, surrounded by a space kept below—200°. Liquid hydrogen commenced to drop from this vacuum vessel into another doubly isolated by being surrounded by a third. Twenty cc. liquid hydrogen were obtained before the hydrogen jet frosen up from the solidification of the air in the pipes. Liquid hydrogen is clear and colorless, showing no absorption spectrum, and the meniscus is as well defined as in the case of liquid air. It has a relatively high refractive index and dispersion, and its density appears to be in excess of the theoretical value 0.18 to 0 12, deduced from its atomic volume in organic compounds, and the limiting density found by Amagat for hydrogen gas under infinite compression. Dewar's experiments have given a density of 0.62 for hydrogen condensed by palladium, and this may not be far from the value for the liquid. No arrangements were at hand to determine the boiling point of hydrogen, but it must be excessively low, for a long piece of glass tubing sealed at the lower end and cooled by immersion in liquid hydrogen immediately filled with solid air where it was cooled. A tube of helium from the Bath gas was placed in liquid hydrogen, and a distinct liquid was seen to condense, thus showing that there cannot be any great difference in the boiling points of hydrogen and helium. All known gases have now been condensed to liquids which can be manipulated at their boiling points under atmospheric pressure in suitably arranged vacuum vessels. With hydrogen as a cooling agent, it will be possible to get within 20° or 30° of the absolute zero, and its use will open up an entirely new field of scientific inquiry.

gas (helium) from the Bath well does not contain argon, and, unless possibly hydrogen is present in small quantity, the helium from the well was pure.

West Oneonta, N. Y.—The West Oneonta and Lawrence Railway Co. has been incorporated by Frank Gould, Parker Wilson, Albert D. Getman, Walter S. Whipple, Harry W. Lee, David S. Peet and R. W. Strong; to build five miles of electric railway between the villages named. Capital stock, $750,000.

Danbury, Conn.—Messrs. Taylor & Starr may give information concerning construction of electric-light plant.

Winnepeg, Man.—No decision has yet been reached regarding the tenders for furnishing an electric light plant. An electrical expert will be engaged to report thereon.

Oshawa, Ont.—The Oshawa Electric Light Company will purchase a 1,500 or 2,000-light alternating dynamo and transformers.

New Market, Va.—A long distance telephone will be put in from Staunton to Eagerstown.

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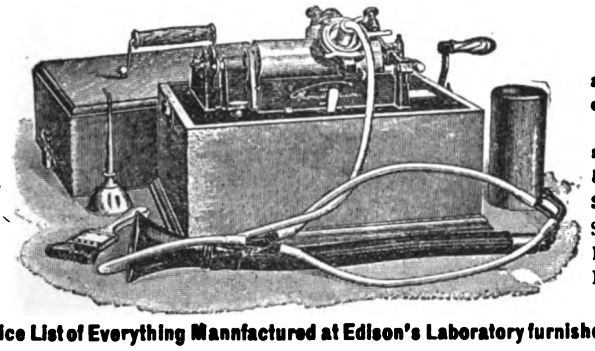

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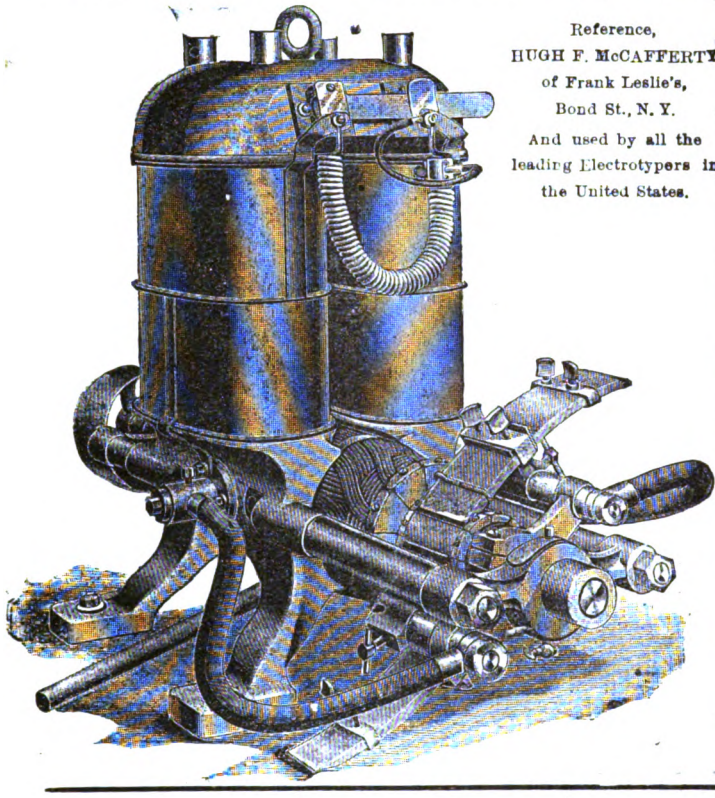

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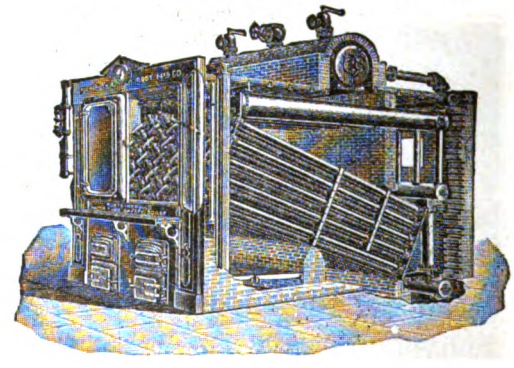

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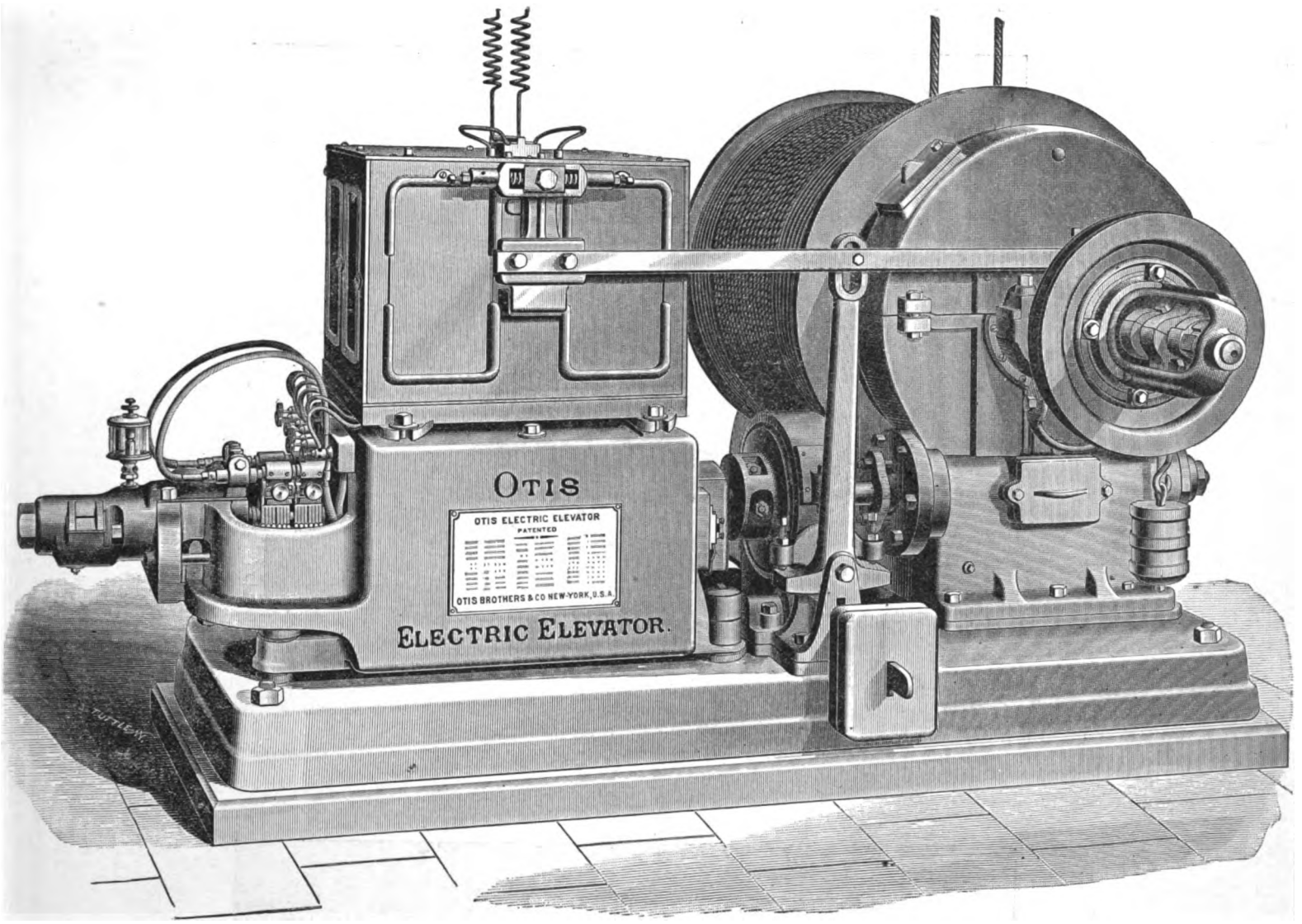
The Electrical Age.

VOL. XXII—No. 5 NEW YORK, JULY 30, 1898 WHOLE No. 585



Otis Electric Elevator Operated by Improved Push Button Device.

PUSH-BUTTON DEVICE FOR OPERATING ELECTRIC ELEVATORS IN PRIVATE RESIDENCES.

The control of elevators from within the car, as well as their control from without, by means of electric buttons, has added a feature to elevator practice which has been carefully followed out by Otis Brothers & Company, 38 Park Row, New York City, manufacturers of hydraulic, electric, steam and belt elevators. By the Otis improved push-button device the movement of the car is controlled electrically from both car and hallways. Inside the car is placed a set of buttons, each button numbered to correspond to the floor to which it will send the car; by pressing one of these buttons the occupant can send the car to the corresponding floor, the car stopping automatically when it arrives at that floor. A safety-button is placed in the car, by pressing which the passenger can stop the car at any point in its travel. An operating button is placed at each landing, by pressing which the car is brought to any floor from which it is desired to use it. These hall buttons are inoperative when car is in motion; the passenger in the car having absolutely the control of the elevator. The inclosure doors are provided with automatic latches, which prevent the opening of any door unless the car is opposite, and when the door is open the electrical circuit is broken, making all buttons imperative and holding the car immovable at that floor until door is securely closed and button pressed. These safety guards reduce to a minimum the danger usually incident to the use of an elevator in a residence where no provision is made for some one person to be constantly in charge of the elevator. It is very likely that in the course of a few years all private houses of any size will have installed in them elevators of this description, which represent all that is to be desired in that department of electrical engineering.

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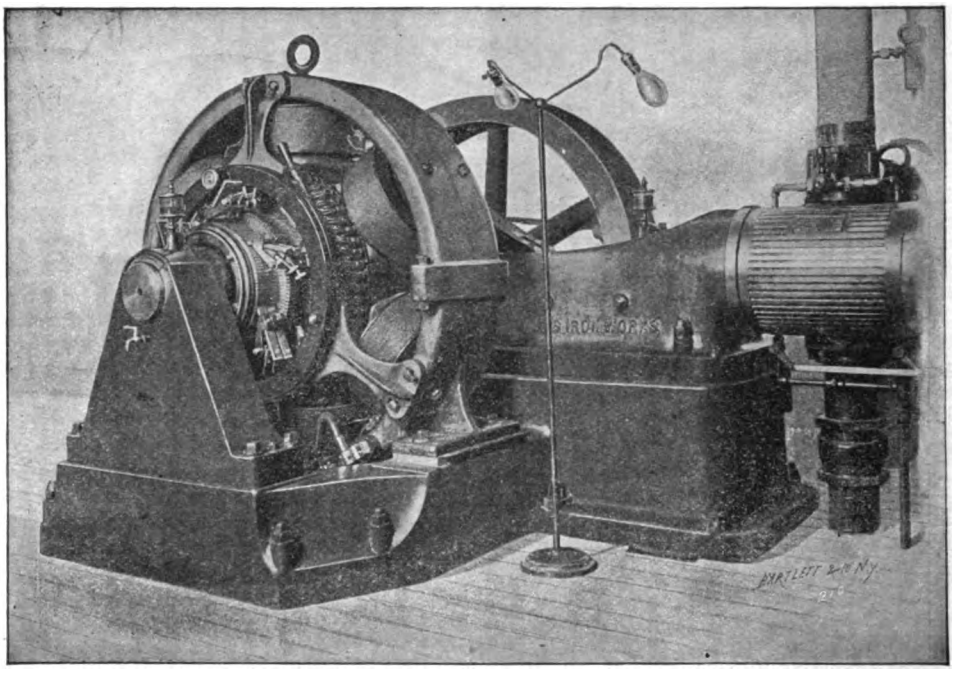
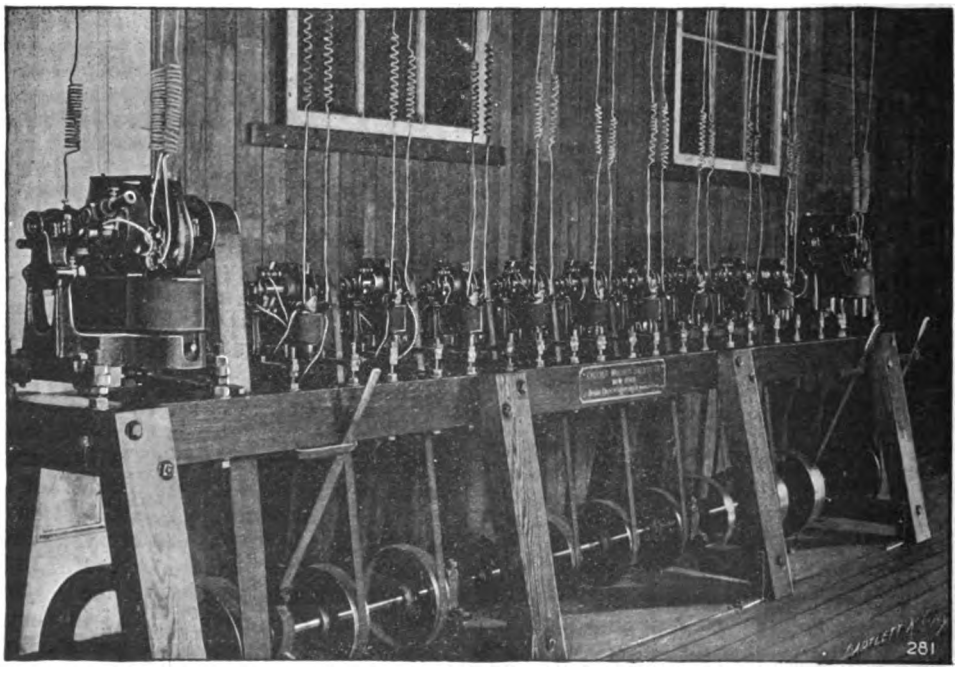
THE DYNAMO IN THREE IMPORTANT CAPACITIES.

The consequence of any great invention has usually been of such a nature as to cause unwonted activity along those lines it comes in contact with. Reference to past inventions of an older nature will lead the reader to the conclusion that the development of the dynamo in all its branches has not differed materially in its industrial value from the steam engine, sewing machine or gas engine. In some of its applications the dynamo undoutedly serves a novel purpose. It has solved the problem, so long discussed, of the best method of supplying power to the telegraph lines radiating and combining all over this continent from the Western Union Telegraph Company. It has eased the mind of many suburban residents in regard to the illumination of their homes, and has enabled municipal authorities to light the streets of large cities so thoroughly that crime has been driven from its hiding place and the slums of large cities rendered safe and pure.

It would be interesting, no doubt, to consider in all its cases the influence of this mere machine upon the progress of civilized races, but the moralist, in his keen search for examples and the causes that lead to goodness or the police station, may perhaps decide with us that the electrician has unconsciously added strength to the efforts made by him and his followers in an ethical direction.



Size 56 C.-W. Dynamo, direct-connected to shaft of 80 horse-power Ames Engine.
Speed, 275 Revolutions per minute. Capacity, 50 Kilowatts.

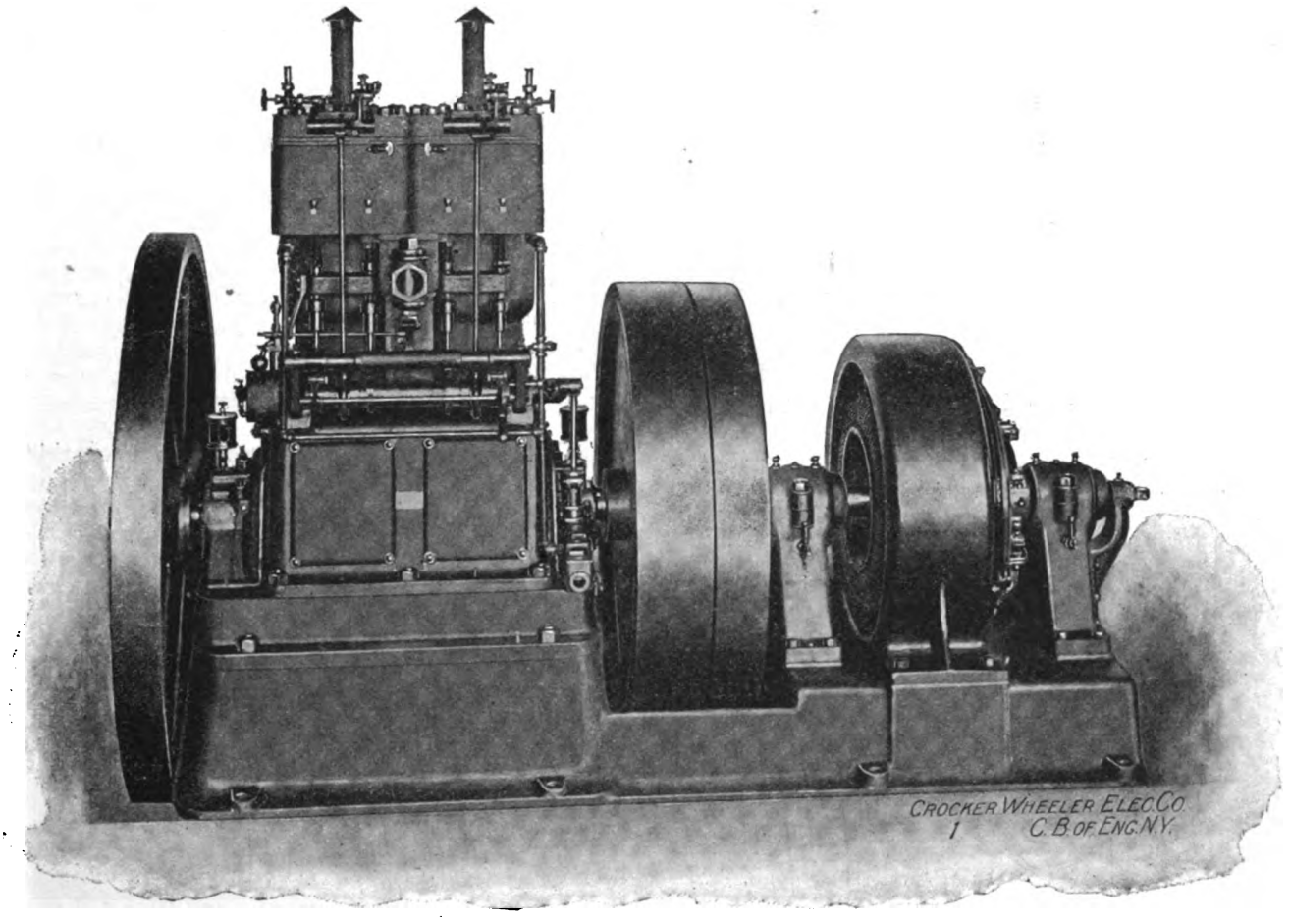


The Old Way. Belt driven. 11 Dynamos. Western Union Telegraph Co., New Haven, Conn., 1892.

The substitution of dynamos of small size for batteries on telegraph lines has proved so successful that in all likelihood they will be extensively employed, with the exception of such small lines as require occasional individ-

ual attention from the country operator. But on long distance lines the dynamo current will be the source of supply, thereby saving the Western Union Telegraph Company thousands of dollars per annum and an immense amount of disagreeable work. For the generation of heavier currents and, in fact, for use in private homes within city limits, gas engine plants are greatly in vogue. Were the size of the gas engine small in proportion to its power, and larger sizes in common use, plants of much greater magnitude would be installed all over the United States.

Where heavier power is required the steam engine is in use, driving dynamos of any size, lighting great towns and running trolley systems miles in extent. It is very likely, however, that the gas engine will keep pace with the dynamo for many years to come; its economy of operation and the absence of care required making it in some respects superior to the steam engine, but inferior as far as the generation of great horse power is concerned. Where skilled aid is not at hand the gas engine electric light plant overrides all competition. But at present the gigantic steam plants in operation testify to their popularity among modern American engineers. A gas engine plant with storage batteries is frequently found in villas and country estates, but until its limits are better defined it will not enter into the race as a competitive factor.



Size 5-100 Dynamo direct-connected to Nash Gas Engine. Crocker-Wheeler Electric Company.

Lonaconing, Md.—The Lonaconing & Westernport Passenger Electric Railway Co. will build power plant to operate its railways.

Rush City, Minn.—The Northeastern Telephone Co. has been incorporated by A. J. Stowe, C. F. Jackson, J. D. Markham and S. A. Nebel. Capital stock, $50,000.

Arlington, S. D.—The Sioux Valley Electric and Telephone Co. has been incorporated by W. J. Maxwell, C. C. Maxwell, M. M. Orlady and A. F. Maxwell. Capital stock, $50,000.

Ottawa, N. S.—Anglo-French Telegraph Co. has been incorporated to construct a line, by means of a cable and land line, from Vancouver to Dawson City, with extensions.

GROOMING AND CLIPPING BY ELECTRICITY.

The electric motor has become a necessary adjunct to every well-appointed modern stable, whether livery or private, and horses are now groomed and clipped by electricity with both neatness and dispatch.

The advantages of the application of the electric motor to grooming and clipping machines were early realized by the American Shearer Manufacturing Company, of Nashua, N. H., and its efforts toward supplying a demand for electrically driven groomers and clippers had met with considerable success. Hitherto, however, it has supplied merely the machinery, exclusive of the motor, but owing to a demand which has arisen for complete grooming and clipping installations, it is now supplying the motor as well. In doing this, however, it has found it necessary to simplify in a large measure the driving mechanism.

Fig. 1 shows the No. 8 grooming and clipping machine, driven by a bipolar motor through double counter-shafting with conical and idle pulleys. This method, while it allows of the operation of two or more groomers or clippers from one motor, was by no means satisfactory on account of the complication of belts and pulleys necessary, and when it became a question of furnishing both driving and operating machinery, it was felt that some more direct method of drive was needed. This was found in the small power moderate-speed motors developed by the General Electric Company, which in addition to its line of small power induction motors has also recently per-

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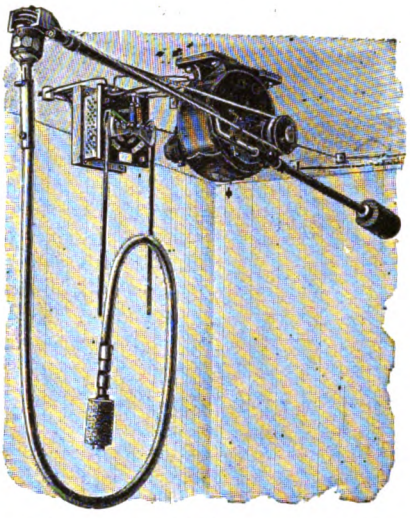
fected a line of direct-current small power motors known as the C. A. type. These motors may be run in any position, either attached to the wall, set on a bracket or hung from the ceiling, and have been found peculiarly adapted to drive the groomers and clippers of the American Shearer Manufacturing Company.

Fig. 2 shows the No. 9 machine complete with a one H. P. C. A. motor and automatic starting rheostat. In this case no floor space is occupied by the motor, the countershafting is eliminated, and the belting is reduced



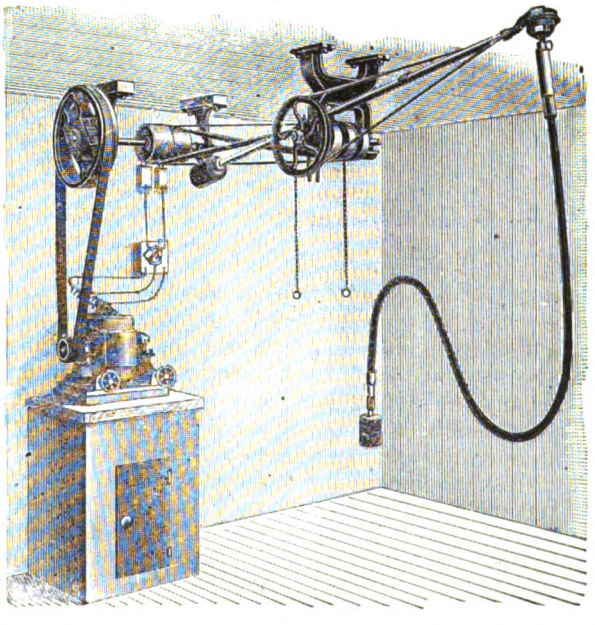
Machine complete with a one-horse-power C.-A. Motor and Automatic Starting Rheostat.

to a single belt from the motor pulley to the pulley attached to the flexible shaft of the groomer and clipper. The motor is fastened to the ceiling beams in an inverted position and the counterpoise, or balance-arm, is attached to a swivel on the motor case. The automatic starting-box, also fastened to the ceiling, is of the reversing type, with the contact arms pulled in either direction by leather straps. This clipping and grooming outfit is singularly compact and simple, and requires almost no attention beyond an occasional oiling. In ordering, it is simply necessary to state the nature and voltage of the current, and, if alternating, the phase and number of alternations.

With the electric motor-driven groomer and clipper, a horse may be thoroughly brushed in about 2½ minutes and clipped in about 35 minutes.

MACHINISTS' AND DRAUGHTMEN'S DATA SHEETS.

An exceedingly valuable data sheet has been prepared by Georg Kirkegaard, of 28 State street, New York City, to be used by machinists and artisans. On this sheet may be found information relating to the horse-power of belting, the size of drills for machine screw taps, the speed of drills of different diameters, proportions of keys for shafting, speeds of machines and screws, and a variety of other figures which would save considerable time to those in possession of them. It is hardly necessary to refer to the loss sustained by the proprietors of large factories in the course of a year through five minutes a day being wasted by each employé. In a large factory one hundred employés would in the course of a year, by hunting around for the size of drills and other mechanical dimensions given in this data-sheet, cost the firm about $600.00 per annum. These data-sheets cost fifteen cents apiece and represent one of the best investments the mechanic can make.



Old Method of driving Revolving Brush through double counter-shafting.

Belleville, Ill —The Madison Telephone Co. has been incorporated by W. H. Johnson, B. L. Behr, E. W. Lazell and T. H. Wright. Capital stock, $25,000.

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SOME PHASES OF THE RAPID TRANSIT PROBLEM.

(Concluded.)

A second modification occurs in the necessity of having stations placed on a level track, and since a train has an appreciable length it must travel its own length before the last car is off the level and the full effect of the grade is felt. Thus, during the first period of acceleration the rate is comparatively small and must be furnished by the motors, resulting in a material reduction in the energy gain in the theoretically ideal profile. An artificial profile can only be secured on elevated or underground roads, and a double-track road necessitates two separate overhead structures, and the underground road must consist of two separate tunnels with unlike profiles.

Assuming two stations to be on the same level, there are two forms of profile that may be assumed with a given maximum difference in levels, as shown in Fig. 6. Profile A consists of a down-grade with a level track at each terminus equal to the length of train operating over the road, while profile B consists of a down-grade and up-grade equal in length and percentage with a level track connecting them, and also a level track at each station equal to a train length.

In practice a perfectly symmetrical profile, as in B, will not be possible, as the level track connecting grades must be replaced by a slight grade to provide for drainage in tunnel roads, this grade preferably opposing the direction of movement of the train.

In order to ascertain the behavior of a train upon the two forms of profiles and to determine the most efficient form of grade, a series of curves have been plotted upon the following assumptions :

Length of run total, 2,000 ft.

Train friction, 15 lbs. per ton constant.

Braking effort, 150 lbs. per ton during time brakes are set.

Running time, 75 seconds.

Length of train, 200 ft., corresponding to an average train of four to five cars.

Tractive effort, as supplied by motors, 100 lbs. per ton. (This effort being supplied irrespective of added effort due to grades.)

No running is assumed to take place on the motor curve, and train is supposed to coast after reaching maximum speed. Motors are controlled by the ordinary series-parallel method, starting with two motors in series and throwing them into multiple, the starting resistance being supposed to be cut out uniformly so that 100 lbs. per ton motor effort is maintained constant while current is on.

Due regard is paid to the fact that the tractive effort due to grade depends upon the proportional length of train off the level track at the stations, and hence is a constantly increasing quantity until the entire train is on grade.

A grade of 4 per cent. has been chosen for the down-grade in A, and for both down and up-grades in B; and energy consumption plotted in Fig. 6 for different lengths of grade.

Thus, for a run of 2,000 ft. in 75 seconds the energy input with series-paralled control is 40.75 watt hours per ton for a level track, which is reduced to 27.8 watt hours in curve A with a length of 500 ft., 4 per cent. grade and 32.6 watt hours per ton in B, with the same length of 4 per cent. grade; that is, with the same vertical fall.

A length of 500 ft. of 4 per cent. grade calls for a vertical fall of 20 ft., which is not excessive in practice; hence, by the use of a profile similar to B, Fig. 6, the energy consumption for a given run may be reduced as much as 40 to 50 per cent. from that required on a level track.

With proper proportioning of the gear ratio of the motor, allowing some acceleration on the motor curve, this saving in energy consumption could even be exceeded, so that a rapid transit road, especially a tunnel road, properly laid out with an artificial profile, could operate with a very much less energy consumption than an existing surface road.

THE DEVELOPMENT OF THE CENTRAL STATION.

AN ADDRESS DELIVERED AT PURDUE UNIVERSITY, LAFAYETTE, IND., MAY 17, 1898,

BY SAMUEL INSULL.

Mr. President and Gentlemen:

When requested a short time ago by the chief of the Electrical Department of this University to deliver a lecture on some subject connected with central station work, I must confess to having had some misgivings in accepting the honor to appear before you this evening, remembering the disadvantages that a commercial man invariably feels in discussing technical matters before those having had technical training, but then I remembered that even within my own time (and I think I can still claim to be a young man) very little was known of the general distribution of electrical energy from a central station, and when I recalled that so recently as the early 80's it was necessarily the rule for "guessing to be a substitute for mathematics" (to use the words of the great pioneer in central station work), my misgivings were inclined to disappear, and I felt encouraged to talk to you on the development of the central station from the point of view of my own experience in following this, the latest of the great industrial developments of the wonderful era in which we live.

In referring to the development of the central station, it would seem hardly necessary to go at length into the history of the business, the origin of which probably dates from the work of the early experimenters whose efforts were directed to the perfection of series arc lighting. Whilst their work is entitled to the greatest possible praise, it should be remembered that the theory on which they worked, namely, constant current and varying potential, is a theory foredoomed to failure, when applied to the development of a system of general distribution for light and power purposes, the first essential of which is the necessity for a constant potential, the quantity of current varying in accordance with the demands made by those desiring to use the energy, whether for light or power purposes. Nor does it seem to me a matter very pertinent to the present occasion to trace the rival claims as to priority of invention of the early experimenters on incandescent lamps. Which of them was the first to produce a lamp that could be brought to a state of incandescence by means of the electric current is hardly within the scope of our inquiry. Probably all of them, groping in the dark (now and then illumined by the flashes of light emitted from their experimental glow lamps), contributed in a more or less degree to the perfection of the incandescent lamp as now in every-day use; but so far as their contributing much that is substantial, in the development of a system of central station distribution, it is probable that, up to the year 1880, there was but one man who realized that in solving the great problem of electrical distribution the perfection of a filament of high resistance, which placed in a hermetically sealed glass globe from which the air had been exhausted and connected in multiple arc across an electric circuit, was the first necessity to the distribution of electric energy in our cities from a central station system.

In Mr. Edison's application for a United States patent on a system of electrical distribution filed at Washington on February 5, 1880, he says:

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"The translating devices for each house may be either for light or power, or both. For light, the electric lamp, consisting of an incandescing material hermetically sealed in glass (shown in other applications made by me) is preferred. This lamp is made of a high resistance in comparison with that of any electric lamps which, to my knowledge, have been proposed. In lights heretofore proposed the endeavor seems to have been to lessen the resistance of the carbon, none having been suggested of higher resistance than, say, 10 ohms; but I have discovered that a very much higher resistance, say 100 ohms, must be used, in order that a number may be economically and successfully used in a system."

The question of the high resistance of the translating device was the first stepping-stone to success. Everybody prior to Edison had aimed at getting a low resistance lamp, I presume, on the theory that the less the resistance of one the less the resistance of the whole series. He struck out on new lines. A high resistance lamp was naturally followed by the multiple arc system.

In writing of the necessity of a high resistance lamp, the applicant for the patent had in mind that a system of electrical distribution could be used at the same time not only for lighting, but for power purposes, if the motors were properly constructed, and this is evidenced by the next paragraph in his application, which states:

"The motors should be so constructed that each, with a constant flow or pressure of current, will give the exact power required. This requires that each motor should be wound with finer or coarser wire, and into more or less convolutions, which determine the maximum effect of the motor."

If you will search the files of the daily and technical journals, and the proceedings of various scientific societies on both sides of the Atlantic from the summer of 1878 up to and including the year 1882, you will find that the great obstacles in the way of an economical system of central station distribution were the difficulties of producing a lamp that would last, one requiring only a minimum of current, and a system of electrical distribution requiring a minimum of capital, so as to enable electricity to compete with then existing methods of illumination and power. Prof. Henry Morton, on December 28, 1879, says in the New York "Times."

"The first difficulty of all is the production of a lamp which shall be thoroughly reliable, and neither complicated nor expensive. All attempts up to the present lamp in this direction are acknowledged to be failures, and, as I have pointed out, there does not seem to be any novelty such as would authorize us to hope for better success than the present one. The next difficulty is the economical production of small lights by electricity. This is what is commonly meant by the phrase, 'dividing the electric light.' Up to the present time, and including Mr. Edison's latest experiments, it appears that this involves an immense loss of efficiency.

"Next comes the difficulty of distributing on any large scale the immense electric current which would be needed, and to provide for their equal action at different points under varying conditions of the number of lights used."

Again, Mr. Conrad Cooke, giving evidence before the British Parliamentary Commission in 1879, in answer to the question: "Supposing that the occupier of one house wished to put out his lights, how would this be effected?" replied:

"In that case, if you throw out a lamp or throw out a house, you must throw into the circuit a resistance exactly equal to what you cut out. If you do not do that, you will affect every lamp in the series and the machine as well. If you put out your lights by breaking the circuit, you put out every light in the series."

In answer to another question at the same Parliamentary inquiry, Mr. Cooke said (referring to Dr. Siemens, who had been named in the question):

"His nephew told me himself that he had seen, I think, over 200 lamps on one of Edison's circuits."

And Mr. Cooke added:

"I must say I should like to see it myself, and that is all I can say."

It is quite evident from this that Conrad Cooke, very well known in England as a prolific writer on the subject of electrical experiments, had in mind, in 1879, nothing better than the series system, that is, a number of incandescent lamps run precisely the same as arc lamps, or, to put it another way, his idea of the electric lighting system was a varying potential and a constant current, which could never be run on a large scale successfully. Sir William Thomson (Lord Kelvin), referring to the same Parliamentary inquiry of 1879, says:

"I had not myself, at that time, any idea leading toward the practical realization of any such distribution of conductors and placing the lights as outlined in the Edison multiple arc and feeder system."

Evidently Mr. Swan, the English inventor, had no idea of the feeder system as late as October, 1880, as in a lecture before the Literary and Philosophical Society of Newcastle, England, at that time, he said:

"The only way of avoiding this waste of energy, without abandoning the idea of small units of light, would be either to employ enormously thick conductors, or have a very limited area supplied from one source."

Mr. Swan was referring to Mr. Edison's plain multiple arc system, as set forth in his application of February, 1880. The last eight words of this quotation prove that Mr. Swan did not then know of Mr. Edison's feeder system, application for patent on which was made on the 9th of August, 1880, and was patented in England on the 24th of September of the same year. It would seem that even in 1882 Mr. Swan, who himself at that time must have been informed as to Mr. Edison's invention of the feeder system, could not have appreciated the possibilities of such a system, as, in a paper communicated to the British Association at Southamptom in August of that year, he stated:

"The only escape from that limitation (extent of distribution) lay in having secondary batteries at stations or in houses, and in these batteries being connected in series and fed by currents of higher tension, the principle still holding of multiple arc, not from the central station, but from the subsidiary ones from which the batteries are charged. Once imagine the possibility of these secondary batteries being kept at a perfectly constant condition of charge by some automatic arrangement, and we might look to that as a means of escaping from the difficulties of wide distribution."

Again we find that Dr. C. W. Siemens, before the Society of Arts in London, on the 15th of November, 1882, said that he thought:

"It would be possible to establish electrical mains in the shape of copper rods of great thickness, with branches diverging from them in all directions, though he was himself decidedly averse to such a plan. He said he would limit the area of the densely populated district to one-quarter of a square mile, notwithstanding other individuals of high standing in electrical circles held that areas of from one to four square miles could be worked to advantage."

Dr. Siemens went on to say:

"In considering the proper size of conductors, two principal factors have to be taken into account: First, the charge for interest and depreciation on the original cost of a unit length of the conductor, and, secondly, the cost of the electrical energy lost through the resistance of a unit of length. The sum of these two, which may be regarded as the cost of the conveyance of electricity, is clearly least, as Sir William Thomson pointed out some time ago, when the two components are equal. This, then, is the principle on which the size of a conductor should be determined."

(To be continued.)

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THE STEAM TURBINE.

The possible use of the steam turbine in lieu of the steam engine has brought it most prominently before the engineering public. In a contemporary of ours we notice that the Hon. Charles A. Parsons has petitioned the English government for an extension of time upon his patent, which was granted on the twenty-third of April, 1884. The efforts of other inventors to create the type of machine he has made a success of failed, and as Mr. Parsons has shown that the invention may have a great influence upon the engineering art in England and other countries, it is likely that five years will be added to the life of his patent, although it seems as though the actual reasons would not be stated until a later day.

We quote from the "Indian Textile Journal," evidence was given as to the great merit of the invention. Machines made in accordance with the invention were being largely adopted and were being bought all over the country. One of the machines had been fitted to a vessel one hundred feet long, which attained a speed of thirty-four and one-half knots—a speed which, it was believed, would be increased if the machines were fitted to larger vessels. Lord Kelvin was called as a witness in support of the petition and said there was no practical steam turbine before Mr. Parsons'. Mr. Parsons' invention gave for the first time a practical steam turbine. There was a great future for the steam turbine. The petitioner's invention had given very good results, and for many purposes it was going to supersede the reciprocating engine; its application to ships being a great step forward. The Privy Council received the petition of Mr. Parsons, considered it favorably, and "Lord Watson said their lordships would humbly recommend Her Majesty to grant an extension of the patent for a term of five years, and they would state their reasons for coming to that conclusion at a later day." It is very likely that Mr. Parsons' plea will be met with favor, and if so in the next few years we may expect marked improvements in the art of using steam for power without the aid of reciprocating parts. All great inventions have in certain respects affected the progress of their originators, and the world's eye has been slowly opened to the fact that its greatest future is dependent upon the efforts of such men as Parsons and Edison of today, as Fulton, Watt and Ericcson of the past. It is in some respects a crime to deny an inventor an extension of time when the invention appears in so glorious a light, with its untold possibilities, as this creation of Mr. Parsons' brain.

Our contemporary further states that "the sympathy of inventors and of the public generally will go with the inventor, who, if his petition is accepted, as it probably will be, may look forward to a period of pecuniary success which has been honestly earned."

MARINE DISASTERS PREVENTED BY THE USE OF ELECTRICAL APPLIANCES.

The steel ship has become in the eyes of many critics a huge coffin ready to sink at any moment into the ocean's depths. The safety of a steamship's passengers depends entirely upon the number of air chambers a vessel possesses and the speed and precision with which they can be closed in a moment of danger; otherwise the great steel shell when struck amidship is like a can with a bottom knocked out, or any other contrivance solely dependent upon its displacement for flotative power, and not upon the inherent buoyancy of the material of which it is constructed. Watertight compartments are practically paid for by the passenger crossing the ocean. They are supposed to render the ship unsinkable, and to rest the minds of those on board at night when dangers come crowding in from the darkness.

At the last accident which happened to the unfortunate "Bourgogne" a general paralysis of action seemed to prevail, leading subsequently to the frightful scenes that followed. But in large transatlantic steamers, upon which money has been lavishly spent in order to obtain the best that science can give, devices should be installed which would instantly close air chambers and open wide all points of exit to those on board.

Few of the passengers on an ocean voyage realize that but a half inch of steel separates them from a watery abyss miles in depth. A fuller realization of this fact would lead them to make demands upon steamship companies before taking passage, thus forcing them to adopt means for the preservation of their lives that would be ready and reliable. It is only when such awful catastrophes thrill mankind with horror that attention is directed to such features of marine construction which become most prominent by their apparent absence.

The use of electrical machinery to close doors leading to air chambers should be enforced and a board of commissioners instituted to make a series of tests with the same for the determination of their efficiency, safety, etc. These experiments should be performed before another boat load goes down, for "an ounce of prevention is worth a pound of cure."

The traveller entering Birmingham after nightfall is greeted by a lurid glow in the distance which soon resolves itself into long rows of columns of flame from one of the great centres of that industry which has served to give it the name of the "Iron City" of the South; for, situated as it is in a valley surrounded by coal and iron mines, as well as immense deposits of limestone, this city is exceptionally capable of producing and, by means of its many lines of railroads, placing in the market large quantities of iron and steel, as well as the manufactured product of these materials.

Birmingham proper is a town of some 70,000 inhabit-

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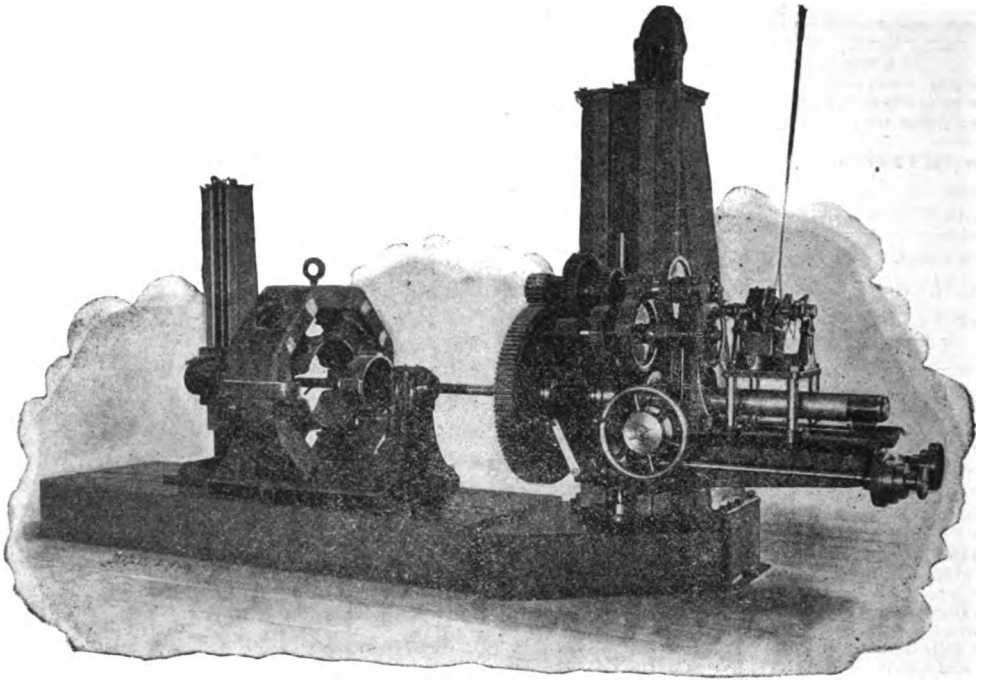
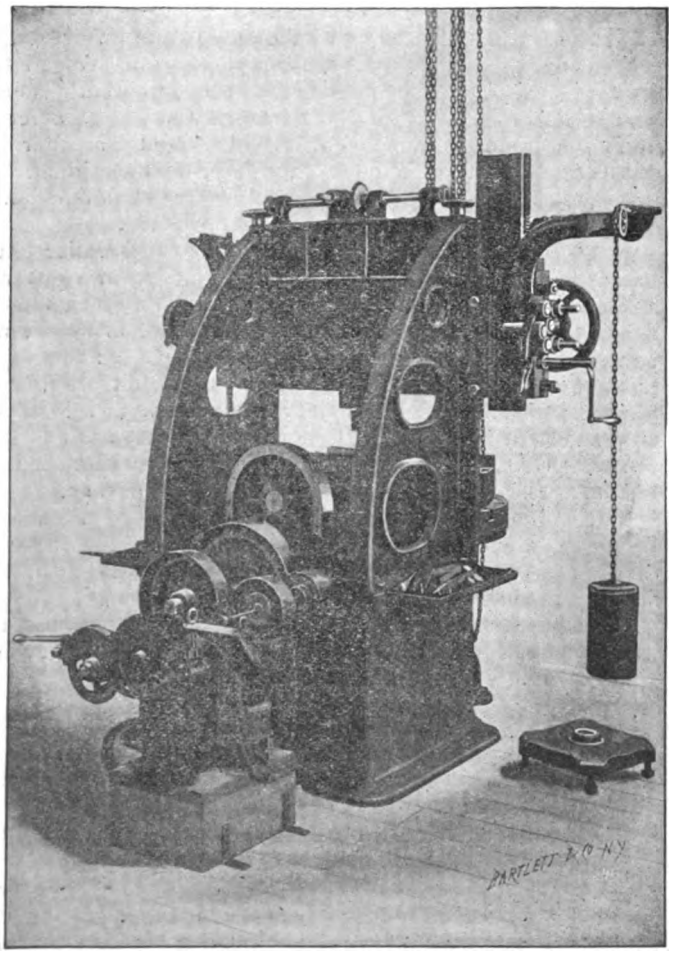
ants; its suburbs cover many miles of the surrounding country, which is everywhere dotted with centres of the iron industry.

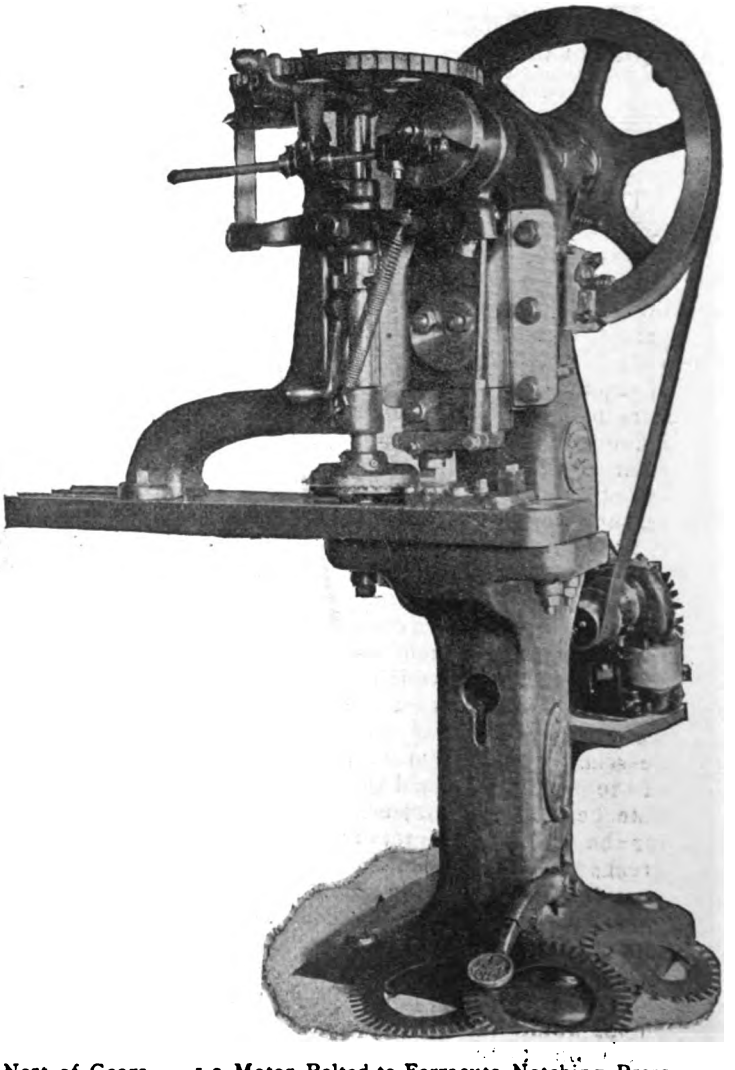


Size 1 C. W. Motor Built on Boring Head and Supplying Power to 10-ton Boring Mill. Speed Changes Obtained by Nest of Gears.

Principal among these are the Shloss and Alice furnaces and the East Lake rolling mill. There are also a



Size 2 Motor, Geared to Vertical Boring Mill. Speed Changes by Nest of Gears.



1-2 Motor Belted to Ferracute Notching Press.

number of immense machine and boilor shops, as well as the Avondale Cotton Mill, recently completed at a cost of $600,000, a cotton-seed oil mill, and two large ice plants.

The former method of street car transportation by steam is being superseded by electric traction, several lines being in operation. We had the pleasure of participating in the inaugural trip and inspection of the Bir-

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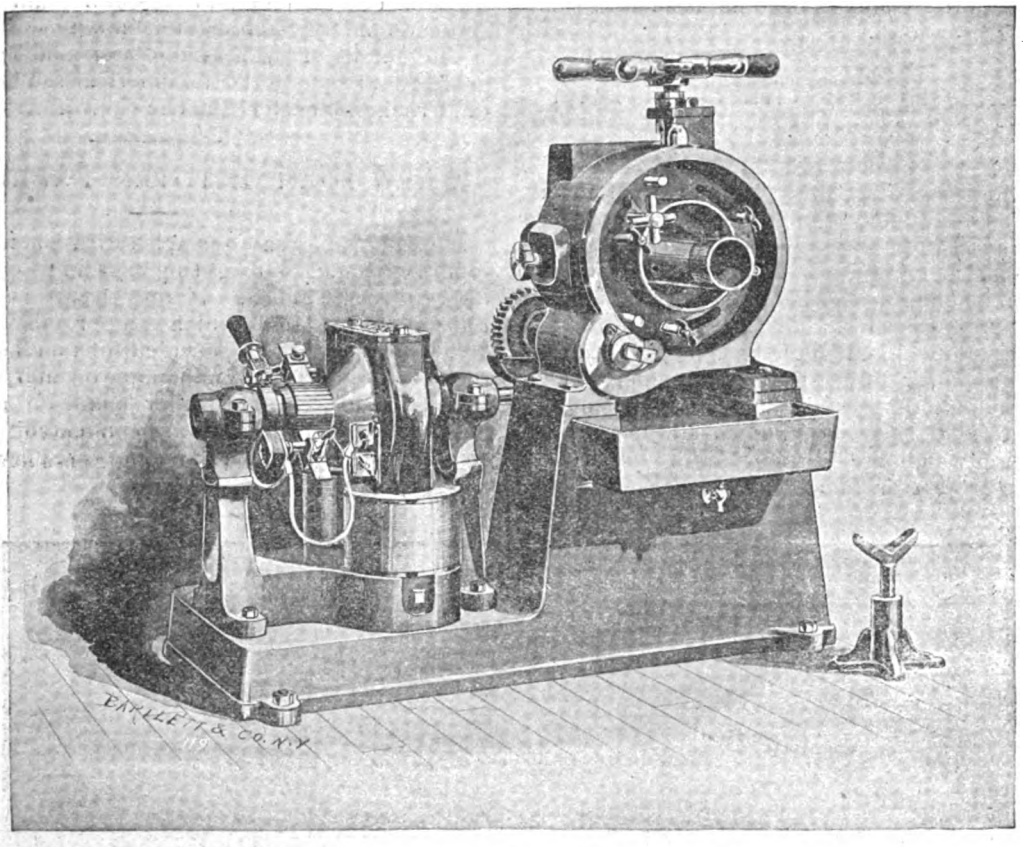
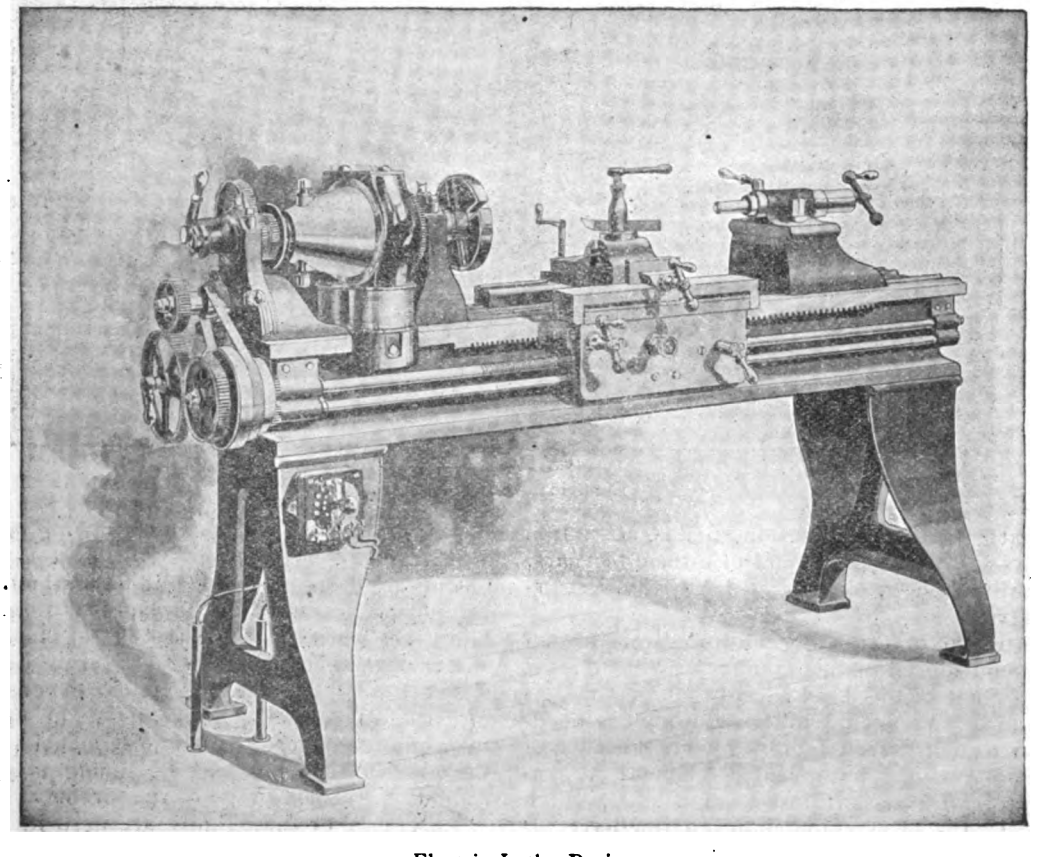
mingham Traction Co. This road runs through the suburbs a distance of six miles; has a well ballasted road-bed. The cars are probably the finest in this section, well finished, equipped with General Electric apparatus, signals from inside the car, vestibules, etc. Their station equipment consists of two 150 K. W., G. E. generators and two Corliss type engines; they as well as the boilers were built in Birmingham.

The Colsolidated Electric Light and Power Co. has a power house covering nearly a city block. They have three large belted engines and have just installed a high speed connected engine, which is, however, not yet in



Motor Combined with Pipe-Threading Machine.



Electric Lathe Design.

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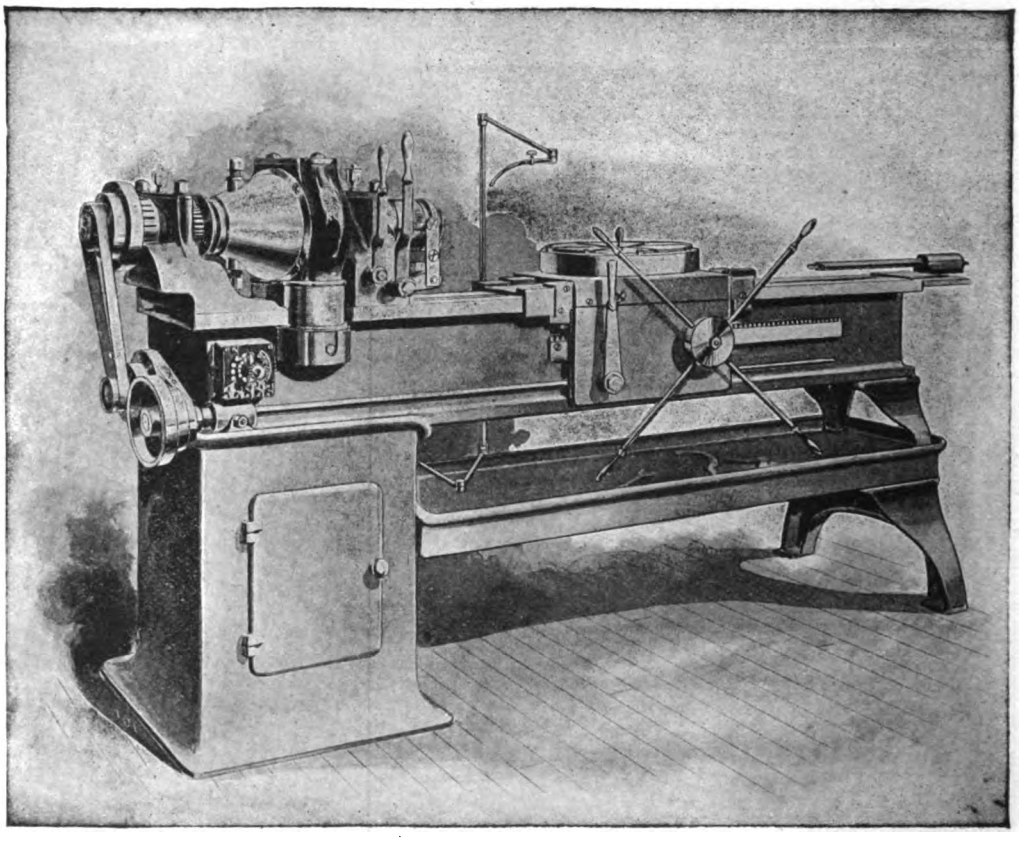
operation; their maximum load is now 2,200 H. P., and is constantly increasing. All of the boilers, piping, and the 150-ft. stack, are home products. Nearly all of the hardest manual labor here is done by the negroes, the height of their ambition being to become firemen in some one of the numerous plants.

THE MACHINE SHOP OF THE TWENTIETH CENTURY.

To prophesy in these times does not mean immortality to the prophet. Judging from the trend of modern progress, it is a matter of simple judgment to forecast the future with almost unerring accuracy. In the respect of using motors on machine tools this prophecy cannot fail to meet with approbation from all interested in the advance and practical development of the electrical science. The authority on power transmission pronounces in its favor, and the manufacturer of such machinery believes that in the practice of this principle certain benefits are gained in the shop which are in their nature inherently beneficial. The proprietor himself can be readily made to conclude that such an installation means an actual saving of dollars and cents at the end of a term of years, which is, naturally enough, to him at least, the best argument in its favor.

The entire problem of attaching motors direct to machines must be considered in this manner. What does it cost to install a plant of this kind? How much money is saved per annum by the saving of power which is needlessly wasted in a belt-driven factory? The absence of countershafts, pulleys, etc., removes an element of danger and a source of constant loss from a shop, which from the earliest days of machine-shop practice have existed. In transmitting power by belt from 30 to 60 per cent. may be wasted, according to our best authorities on this subject. In very large factories, where the machines are in constant use and the source of power is near enough to the shop or shops to prevent this waste, direct-connected machines are not necessary. But in the majority of cases where such conditions do not prevail, and this leakage is continually occurring, direct-connected machines equipped as those seen in the illustrations will transform an ancient and wasteful plant into a modern and economically-run establishment.

The details of such saving and sufficient evidence to prove that it is not at all chimerical can be obtained from the Crocker-Wheeler Electric Co., of Ampere, N. J.



Electric Monitor Design.

A NEW FORM OF POTENTIAL REGULATOR.

One of the great obstacles with which the series system of incandescent lighting has had to contend has been its want of flexibility. If the circuit is laid out for the full number of lamps which the normal voltage will operate, a means must be provided for increasing the voltage to take care of additional lamps ordinarily called for for a short time. On the other hand, if only a part of the possible number of lamps are connected in circuit, expensive or complicated arrangements are necessary to absorb the surplus voltage.

To regulate the voltage the following methods are used:

Extra lamps are installed at the station and cut in or out of circuit as required. This method is expensive, as the power consumed in the lamps is totally lost, and the lamps are worn out while their light is wasted.

Reactive coils are placed in series with the circuit at the station. This method is also expensive, because the electromotive force of the coil is out of phase with the voltage of the circuit, and, consequently, the voltage produced within the coil will be much more than the actual reduction in the voltage of the circuit.

Reactance or shunt coils are used in connection with each lamp in the circuit. Such coils can only produce approximate compensation for the lamps that may be extinguished and are not satisfactory for compensation for the lamps permanently out of circuit, for the same reason that reactive coils are not satisfactory.

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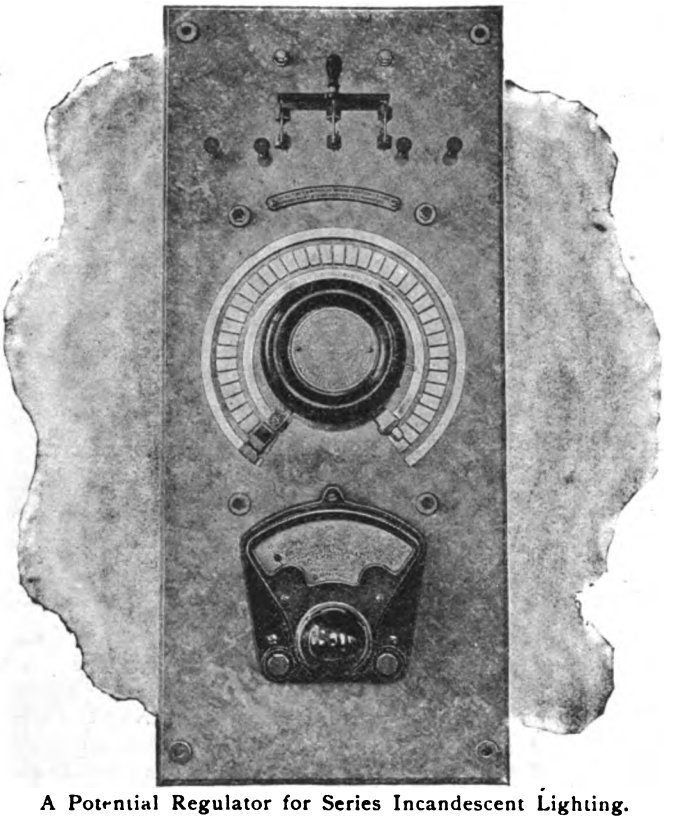
For satisfactorily controlling the voltage, the General Electric Co. has developed a form of potential regulator especially adapted for this work, by the use of which the series system becomes almost as flexible as a parallel system and the power consumed in the circuit varies directly in proportion to the number of lamps in use. A regulator panel, with ammeter, switch and fuses, is shown in the illustration. The regulator is mounted on the back of the panel, and consists of a compensator, from the secondary winding of which taps are connected to a set of contact blocks arranged in circular form on the front of the board. A hand wheel in the centre of the ring of contacts operates two arms carrying brushes which connect from the contact blocks to continuous rings on the inside and outside of the contact blocks. One of these arms is connected directly to the hand wheel; the other is connected through a bevel gear, so that the direction of rotation of one arm corresponds to that of the hand wheel, while the other moves in the opposite direction.



A Potential Regulator for Series Incandescent Lighting.

The compensator is so connected that whatever difference of voltage exists between the two concrete rings on the dial switch is added to or subtracted from the initial voltage of the circuit. If one arm be directly over the other, there is no difference of potential between these rings. If the hand wheel be turned to the left, a gradually increasing voltage, which will be added to that of the line, will be developed between the rings, while a gradually decreasing voltage, which will be subtracted from the initial voltage, will be developed if the hand wheel be turned to the right. The ammeter below the hand wheel indicates the current in the circuit. When the number of lamps in circuit is changed, it is simply necessary to turn the hand wheel until the proper current is indicated.

The compensators are wound for the standard currents of 3, 5, and 5.5 amperes, and in either case will increase or decrease the initial voltage of 1,150 or 2,300 by 230 volts. Special regulators giving a greater range of voltage will be built, if desired.

"ELECTRO-DYNAMICS," published by Longmans, Green & Company, has for its author Charles Ashley Carus-Wilson, professor of electrical engineering at McGill University, Montreal. The book is practically a treatment of the direct-current motor, considered from a purely scientific standpoint. By this is meant not a complete adherence to the purely scientific side of the question, but a consideration of those principles upon which the construction and design of all direct-current motors should be based, with further elucidation of them by reference to practical examples. In this respect the book is unique and in many senses complete. It appeals to the student of electro-technics as much as to the practical mind, and in the scope of its treatment includes information relating to the efficiency, winding and design of motors which will be approved of by the highest critics and students in the electrical profession.

NEW ELECTRICAL INCORPORATIONS AND BUSINESS CHANGES.

Manhattan, N. Y.—Peekskill Traction Co. has been incorporated by Charles Mason, M. D., James H. Haight, Frank Frye, Charles N. Wells, Jay R. Decatur, Matthew Clune, James F. Martin, Hanford Smith and Jacob Larsch. Capital stock, $150,000.

Columbus, Ohio.—The New Harrison Telephone Co. has been incorporated by Geo. W. Hull, H. T. Hull, L. C. Cunningham, D. W. Morris and John P. Manton. Capital stock, $100,000.

RAILWAY MOTORS AND CONTROLLERS.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

The use of motors for track service is limited to those of the series type. A series motor possesses advantages over the shunt that both experience and theory advocate. The current flowing through a series motor passes from brush to brush via armature and field. The speed and pull of the armature can be changed at will by varying the pressure applied to the armature aud its current and field.

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The pulling power of any armature depends upon the

(1) Current in the armature.
(2) Strength of field.

The series motor is naturally adapted by its construction to an easy system of regulation. Not only can the current be varied outside by having a rheostat in series with the motor, but the magnet coils can likewise act in this capacity by being subdivided. A series motor connected to a rheostat and having commutated or subdivided field coils can be regulated both in speed and power by these means.

A trolley car is usually equipped with two motors. They are both series motors with commutated field coils. A small rheostat is in series with the pair. To vary the speed and pull of the car an automatic switching device called a controller is used.

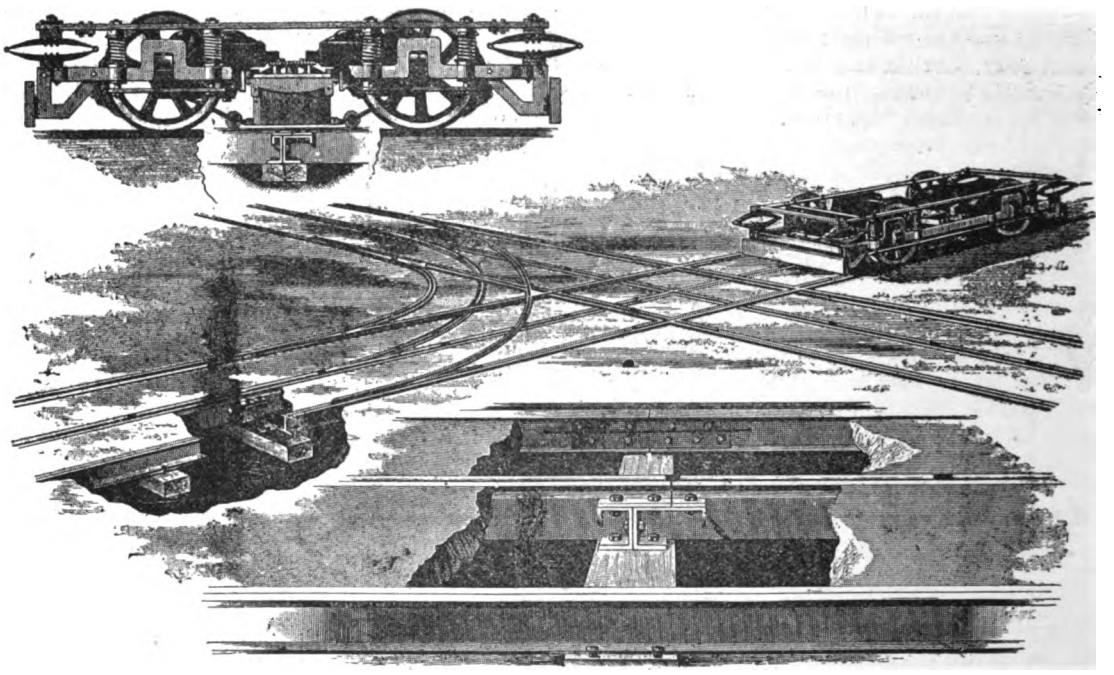
Function of a Controller.—When the car is at rest the rheostat and both motors are in series. To start the car and put it through its different speeds, the controller, which consists of a cylindrical vertical commutator, is revolved. The general result is as follows:

(1) The rheostat and two motors in series.
(2) The two motors thrown in multiple.
(3) Subdivided fields thrown into multiple.

To each of these general processes there are subdivisions; that is, the rheostat contains steps which regulate to some extent—the motors may be thrown in multiple, or their fields and armatures separately, and in addition different combinations may be made of the commutated fields. The practical result of all these changes is to increase the current flowing through the motors by successive stages until the pressure and current is at a maximum.

The heaviness of motor cars has necessitated the use of strong steel rails and a secure bond. The cars used are not very different from the old horse-car style, except that they are better furnished, more capacious and in every respect more comfortable. Both station, track, car and motors are a source of expense to the company. The station has machinery which depreciates; the track requires many repairs unless well put down, and even then the rails wear out; the motors have armatures which constantly burn out and the cars become scratched and shabby from daily use.

Trolley lines running over hilly ground are apt to incur more expense from repairs than those installed on more level road. The reason for this is traced to the greater strain upon the motors when climbing hills. The work the motor performs is divisible into two parts—that of advancing and that of lifting itself the height of the hill. In certain localities it seems evident that a cable system would be best; that is, a very hilly district. Block electric, open conduit and storage battery systems are occasionally heard of. In New York City, perhaps, the conduit system is receiving the best trial of all. Several of our largest railroads are about to permanently adopt electric cars for special purposes; the B. & O. being the most prominent of all.



McLaughlin's Conduit System.

QUESTIONS FOR REVIEW.

(1) What type of motor is used for track service?
(2) How is the pulling power of the armature governed?
(3) Describe the equipment of a trolley car?
(4) What is a controller?
(5) What general arrangement of circuits takes place?
(6) When is cable or electricity best adapted to the locality?

Pueblo, Col.—A new telephone company has been organized.

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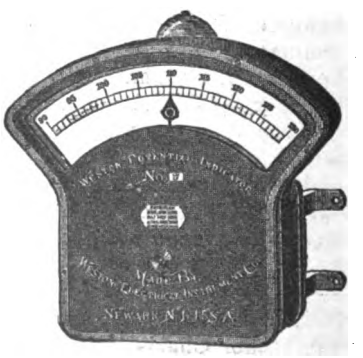

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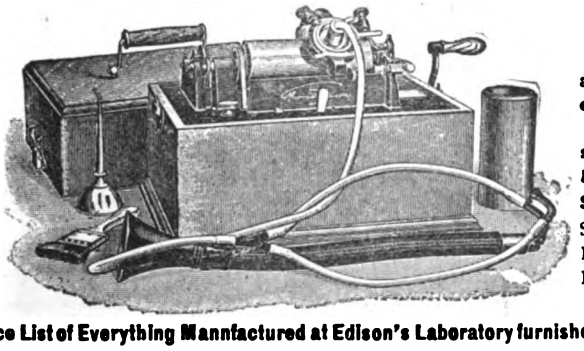

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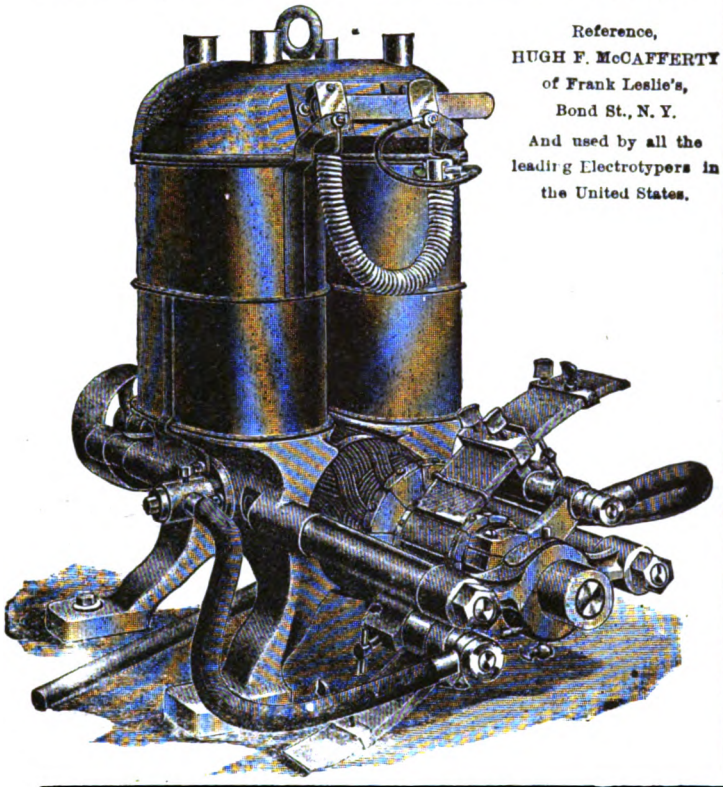

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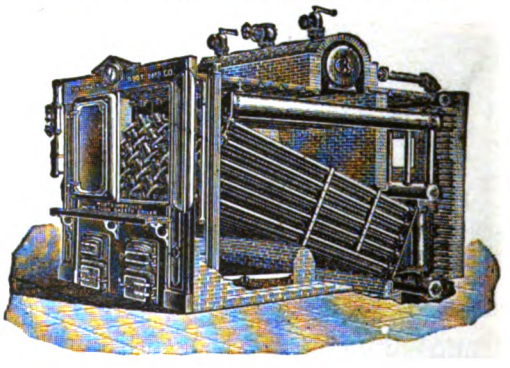

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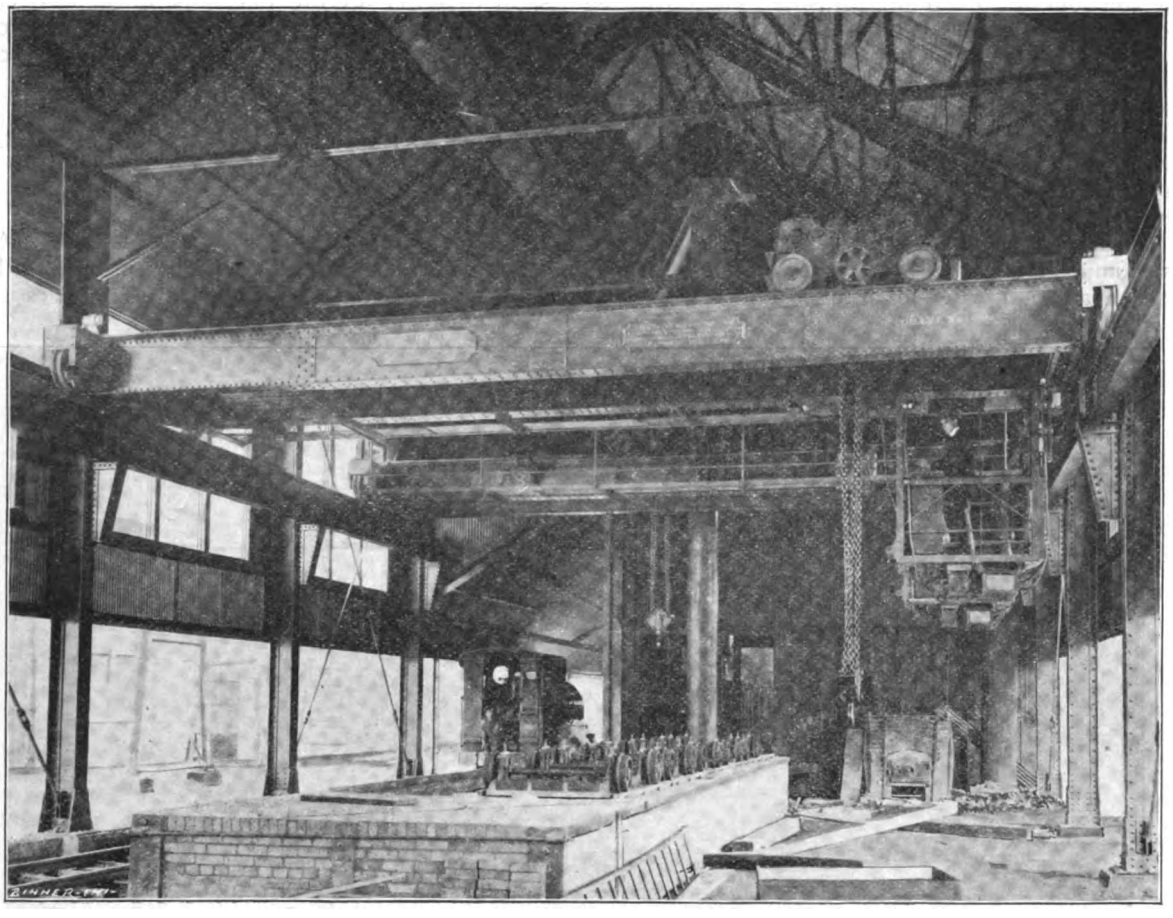
The Electrical Age.

VOL. XXII—No. 6 NEW YORK, AUGUST 6, 1898 WHOLE No. 586



Electric Travelling Crane built by the Case Manufacturing Co. of Columbus, O., installed in Laughlin's Works at Martins Ferry, O

ELECTRIC TRAVELLING CRANES OF THIRTY THOUSAND POUNDS CAPACITY.

The construction of heavy machinery has had its influence upon the world's progress in more ways than one. In large factories and manufacturing plants the transportation of heavy weights from point to point involves the use of some sort of crane substantially built and capable of withstanding a strain of many tons. Manufacturers have discovered in the course of their experience that frequently the profits of the concern they pilot through the channels of trade depend largely upon the time saved in handling the material placed upon the market. It is therefore evident to them as well as the general public that all time-saving devices, and machinery built to facilitate internal operations in factories represent an investment which is constantly paying dividends to the investor.

The electric travelling cranes built by the Case Manufacturing Company, of Columbus, O., illustrated in these columns represent a type of machinery which in every respect answers to the above description from an economical and commercial standpoint. Two large electric cranes having a capacity respectively of twenty thousand and thirty thousand pounds have been installed in the works of the Laughlin concern, at Martin's Ferry, O.

From a technical standpoint these cranes have fully satisfied the purchasers. They represent a combination of strength, efficiency, and comparative lightness which give them a superior position in the eyes of the engineering fraternity. The motors operating these cranes are covered up from all possible contact with dust or dirt and their overload capacity is very great.

Cranes have been tested to twice their rated load without perceptible vibration or injury to the motor. This percentage of overload without detriment to the machine shows a design and construction of the highest order, and is entirely due to the science, care and skill exercised in their actual construction. The main girders and end-truck frames are so solidly connected that the girders could not possibly interfere with the operation of the wheel base by getting out of line.

Among other points of interest in the construction of this crane may be noticed the mechanism utilized for the purpose of lifting a given load. It is impossible for the weight to react by reversal, because it operates automatically in securing itself at any given point. A magnetic brake adjusted to the hoisting mechanism interferes with the continued action of the motor after the switch has been turned off, bringing it to a state of absolute rest.

In order that the operator may give the bridge the care

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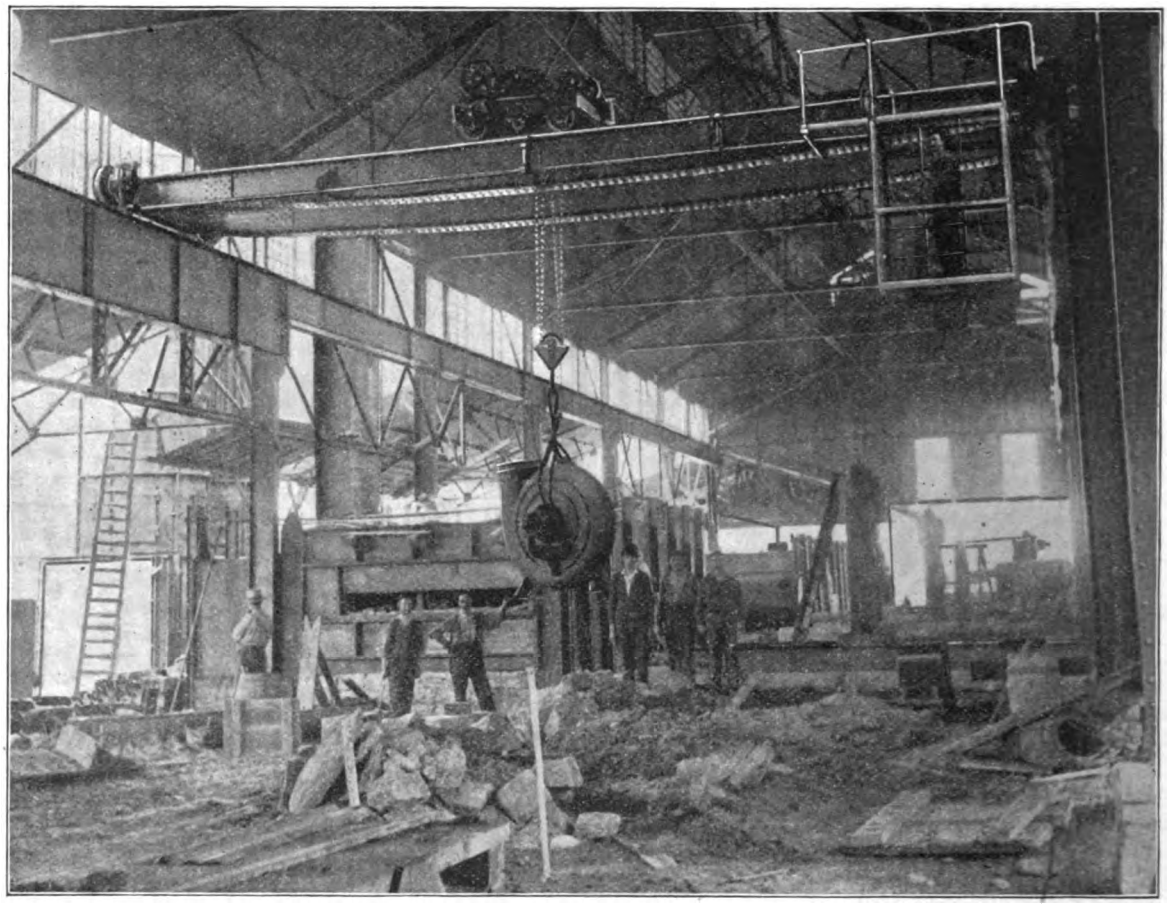
and attention it requires, the motor giving it movement is placed in this crane above the operator, or at least above the stand from which he controls the entire crane. The position of the operator is a most convenient one with reference to the crane and bridge-moving motor. His cage is large and conveniently arranged, so as to allow of ample freedom in controlling the speed and operating other devices controlled from his stand. The bridge is so built that the operator may walk along its entire length without inconvenience and pay particular attention to every part of the mechanism. The operator's switch-board has been carefully designed in every detail, and represents a most practical and convenient arrangement of wires and switches.

The mechanical details that enter into the construction of the hoisting gear are as follows: the hoisting gear itself is composed of two drums, each drum grooved spirally with a chain winding around it from each end to the middle. A great advantage of this construction is due to the fact that in raising or lowering the load the chains on each drum are inclined towards each other an equal number of degrees, thereby preventing any torsion of the block.



Electric Travelling Cranes of the Case Mfg. Co.

It is hardly necessary to add in conclusion that many parts of these cranes are interchangeable, the removal of parts can be made with the utmost facility and dispatch; the strength and quality of the steel, bronze, etc., used is of the highest and best. The ready application of these cranes to the work of large shops is such that we can safely predict their universal use in the course of a few years.

The Case Manufacturing Company have succeeded so well in the construction and installation of electric cranes that some of the largest concerns in the country now regard them as authorities in the theory and practice of electric crane construction. Let another ten years sweep us within the limits of the twentieth century and we will find electrical apparatus of the most gigantic proportions used in lieu of deficient, uneconomical and old-fashioned mechanical contrivances that have lived through their period of usefulness and been relegated with hosts of similar relatives to the scrap heap.

An era of change is at hand which will bring material advantages to those concerns gifted with enough foresight to anticipate the demands of the next century and with sense enough to develop a trade in those things most beneficial to the arts and applied sciences of that period.

THE EFFECT OF HEAT ON INSULATING MATERIALS.

BY PUTNAM A. BATES AND WALTER C. BARNES.

A paper on this subject was presented before the American Institute of Electrical Engineers on May 20, 1896,* by Messrs. Sever, Monell and Perry. In the discussion which followed, the results were questioned by several members, and Mr. C. F. Scott cited some investigations of Mr. Skinner, who obtained curves which differed very considerably from those shown in the paper.†

This left the subject in such an unsatisfactory condition that it was decided to make further tests with the object of reconciling the differences or determining what the real facts are.

In our investigations, more attention has been paid to the actions which take place when one kind of material is subjected to tests while the conditions are varied, rather than a great number of tests on different materials under the same conditions.

In fact, it has been deemed wise to conduct all the tests on one kind of material, it being safe to conclude from results previously obtained, that the action on it

* Transactions, vol. xiii, page 223.
† Ibid, page 237.

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would be quite similar to that produced on other samples. Therefore the ordinary "red fibre" insulating material having the general appearance of thick red paper, has been selected. Its thickness is about .009 inch.

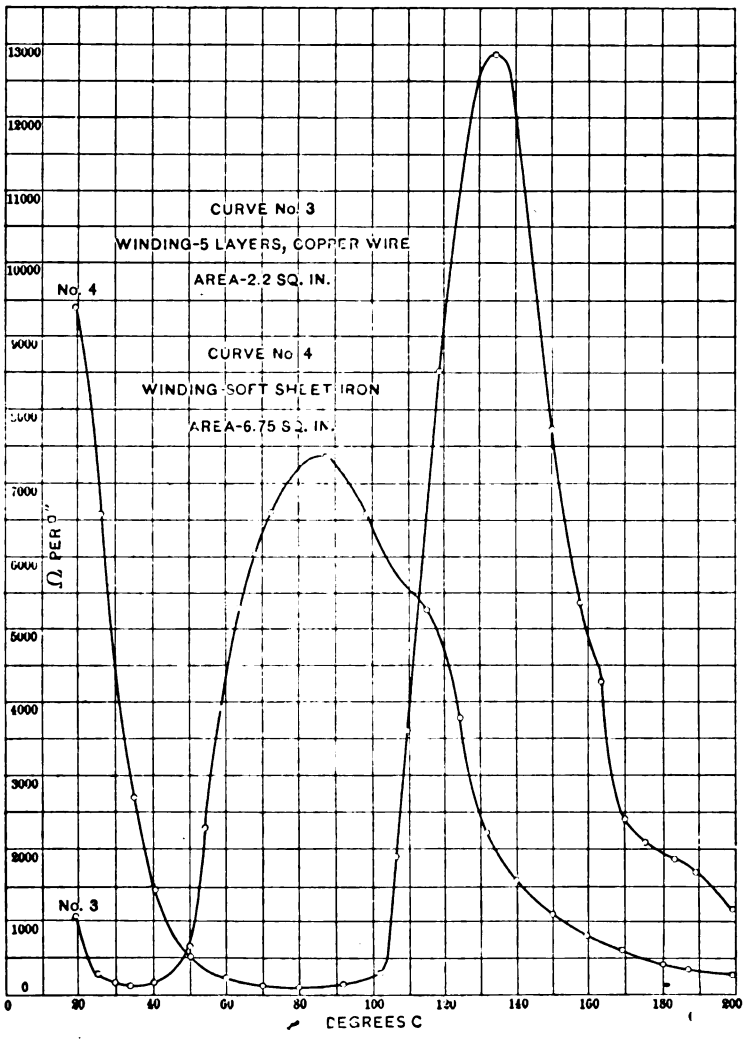

Fig. 2.

The Apparatus.

This consists of two distinct parts, viz.: the device for heating and that for testing the insulation resistance. The heating apparatus consists of a single electric heater, having a radiating surface of 47 square inches. This is nothing more than six resistance coils tightly packed with asbestos in a short sheet iron cylinder, whose lower end is open.. The terminals come from the ends of this set of resistance coils through the bottom of the heater, and are then connected through a suitable switch to a 110-volt circuit. This heater is supported on three porcelain insulators, which rest on a slab of slate one and one-half inches thick and one foot square. The heater

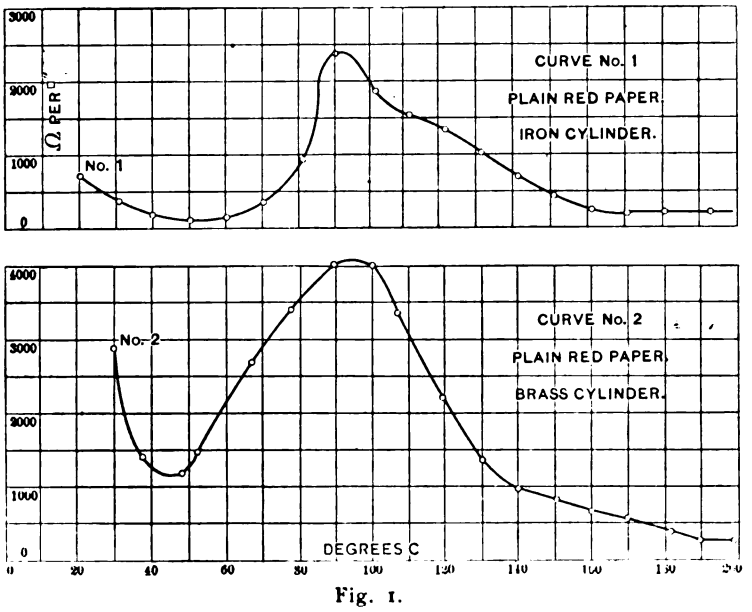

Fig. 1.

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takes exactly four amperes of current when all other resistance is cut out of the circuit.

Around the heater is placed an earthenware cylinder one foot high and nine inches in diameter. This provides an excellent method of keeping the heat in, and together with the electric heater secures perfect regulation of temperature. The terminals of this heating circuit are brought directly down and out from the heater through the base slab of slate to the terminals of a 110-volt lighting circuit, and are thus kept entirely separate from any other part of the testing apparatus.

Resting on an asbestos collar and at a height of about 2 inches above the heater, in the earthenware cylinder, is placed a circular iron plate ⅛ inch thick, which is one terminal of the testing circuit itself and is connected to one binding post of a Thomson high resistance galvanometer; a standard megohm being placed in series between the two.

The insulating material to be tested is wrapped on an iron cylinder 3 inches in length and having an external diameter of .875 inch, the insulation not quite reaching to the ends of the cylinder. The insulation is then wound with No. 26 B & S bare copper wire. This winding makes the other terminal of the testing circuit, and is connected to the other post of the galvanometer. The iron cylinder, upon which the insulation is placed, is then placed upright on the above mentioned iron plate. Thus it will be seen that the insulating material now separates the copper wire winding, as one terminal, from the iron cylinder which is now in contact with the iron plate, as the other terminal. The leading-in connections to these terminals pass through small holes bored in the earthenware cylinder. Glass insulators are used in these holes in order to prevent any current from creeping across from one wire to the other over the surface of the earthenware. Heavy covers of asbestos board are placed over the top of the earthenware cylinder and this again is entirely covered with a large glass globe.

The potential used in this circuit is 500 volts. A suitable shunt, consisting of one or two turns of bare copper wire wound on each end of the sample of insulation, so situated that they would intercept and shunt past the galvanometer any current tending to leak along the surface of the insulation from the iron cylinder to the winding, that is, from one terminal to the other, is used in order that a deflection of the galvanometer will be produced only when a current actually passes through the insulating material under test.

In making the apparatus we have been particular to eliminate all metals with the exception of iron and copper, thus avoiding any possibility of the volatilization of zinc, which was one of the points raised in regard to the previous tests.‡

This apparatus, when complete, works admirably, absolutely no difficulty being experienced with either the heating or the testing circuit.

The questions that we have attempted to answer by this investigation are four in number, viz.:

1st. Does the presence of brass or other metals from which zinc may become volatilized, in the apparatus in which the test is conducted, affect the insulating material or its behavior?

2d. Why should one experimenter obtain an insulation resistance curve for fibre, whose minimum point is at about the same temperature as the maximum point of an insulation curve obtained from similar material by another experimenter?

3d. What effect on fibre insulating material is produced when it is subjected to conditions similar to those likely to occur in dynamo-electric machinery?

4th. What is the action, or actions, that take place when fibre insulating material is repeatedly heated from 20° C. to 200° C.?

Question No. 1 has been approached in the following manner: The resistance of the insulating material at the temperature of the air, or 20° C., being determined, the temperature is gradually raised until 200° is reached, when the test is discontinued. The time taken for this rise was exactly 2½ hours. Resistance measurements are made at frequent intervals, and from these curve No. 1 is plotted. The area of insulation tested being 5.5 square inches, thickness = .0095 inch.

The position and shape of this curve agrees very closely with the results obtained by Messrs. Monell and Perry, who in their experiments used a brass cylinder, but a confirmatory test with a brass cylinder was also made in our apparatus. This experiment was deferred until the completion of all other experiments.

Curve No. 2 thus obtained from a like sample of insulating material, thickness .0095 inch, area tested = 4.6 square inches, showed that the presence of brass in the apparatus does not affect the shape or position of the curve.

In taking up question No. 2 it is intended to prove, by comparative tests, that the position of the maxima and minima points of the resistance curves depends upon the opportunity of escape given to the moisture originally contained in the specimen.

Curve No. 3 shows the results from a test on a sample of plain red fibre, thickness .009 inch, the area of insulation under test being 2.2 square inches. In this case five layers of No. 26 B. & S. bare copper wire were wound closely upon the fibre, the length of winding being only .8 inch.

Curve No. 4 has been obtained from a test on a specimen cut from same sample wrapped with a sheet of thin malleable iron held in place by a number of layers of tightly wound copper wire, thus approaching the conditions under which the experiments cited by Mr. Scott were made. The area covered by this iron wrapping is 6.75 square inches. This test consisted, as before, in gradually raising the temperature from that of the air to 200° C., the resistance being measured at frequent intervals. The curve obtained under the above conditions is almost identical with that published by Mr. Scott.§

It is clear from these two experiments that the position of the curve may be shifted at pleasure by simply varying the opportunity for the escape of the moisture originally contained in the insulating material. That is to say: if we wind our specimen with wire and only cover a small area, we find that the moisture has a much better chance of escape than if completely covered with an iron wrapping extending over a large area, and that the curve will actually take a position depending upon the rapidity of escape of the moisture. In the case of the wire-wound specimen the moisture escaped not only through the interstices between the wires, but also, and to a much greater degree, from the exposed ends which it reaches through the pores of the material; while with the iron-wrapped specimen the only chance of escape is from the exposed ends. Therefore, the greater the area covered, the longer will be the path traversed by the moisture and consequently a longer time or higher temperature will be required.

Question No. 3. A new specimen of plain red fibre .009 inch thick was wound with four layers of No. 26 B & S. bare copper wire, the area covered being 4 square inches, and then subjected to the variations in temperature and exposure to moisture which are most likely to take place in dynamo-electric machinery.

Insulating material when used in this way is subjected to repeated heating and cooling, being kept at a moderately high temperature for varying lengths of time; also being exposed more or less to the moisture in the air. Therefore, the following eight tests have been made under conditions approximating the above and upon the above-described specimen.

In all of these tests the temperature is gradually raised from that of the air, 20° C., to 80° C., at which temperature it is kept constant for 3½ hours. The time taken

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to raise the temperature this amount is about 45 minutes.

Curve No. 5 has been obtained from the first heating. The specimen was then allowed to stand unexposed to moisture for sixteen hours, at the end of which time a like test is made, giving curve No. 6. After a lapse of 24 hours, during which time the specimen was exposed to the atmosphere, which was very damp, the temperature is again gradually raised and kept constant as before, curve No. 7 resulting.

It will be seen by examination of these curves that the specimen after exposure to moisture returns to its original condition. The method of exposing the specimen to moisture is to remove the glass globe from the apparatus and the asbestos covers from the top of the earthenware cylinder, the specimen itself being undisturbed. Three days (72 hours) having elapsed, the specimen being undisturbed and unexposed to the atmosphere, is subjected to further test, giving curve No. 8.

Great care is now taken to protect the specimen from all moisture for sixteen hours; at the end of which time, upon again testing, curve No. 9 is obtained. The test consisted, as before, in raising the temperature to 80° C., where it was kept constant for 3½ hours.

All covering is now removed and the specimen allowed to cool to 23.3° C., the time occupied being three and three-quarter hours. Curve No. 10 is then obtained upon reheating.

Again great care is taken to protect the specimen from disturbance and all moisture for nineteen hours. On being again subjected to test, curve No. 11 results.

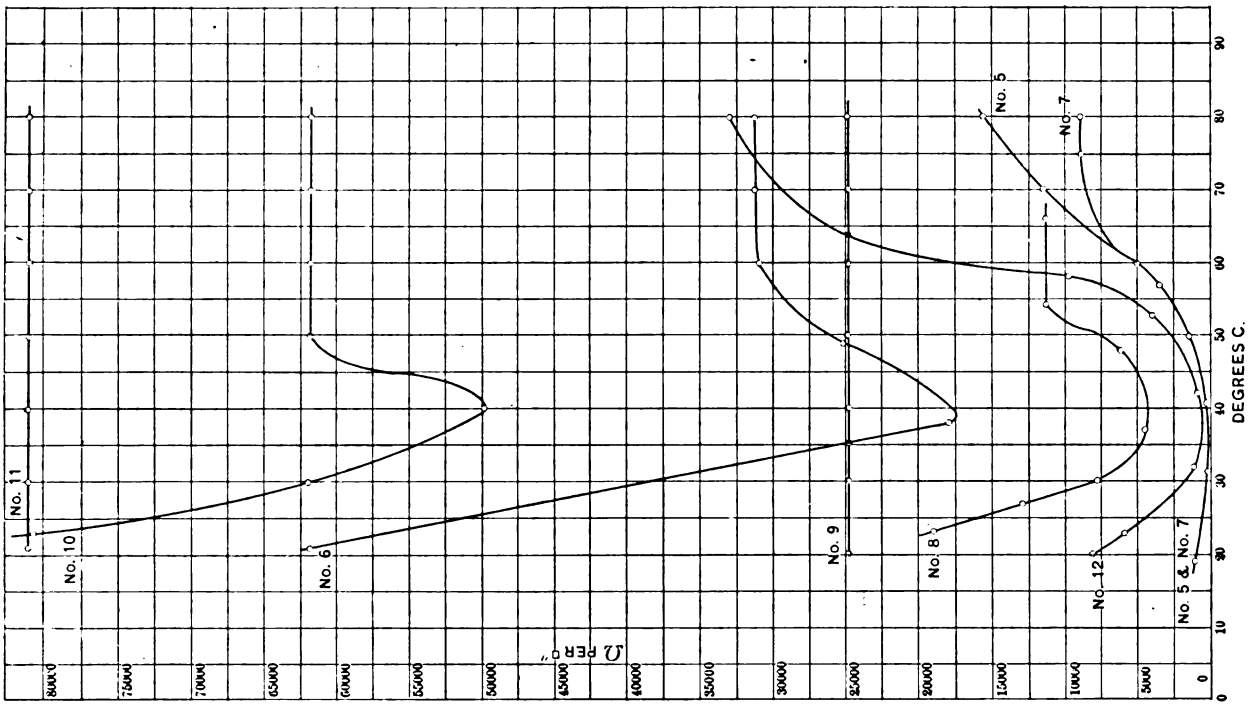

Fig. 3.

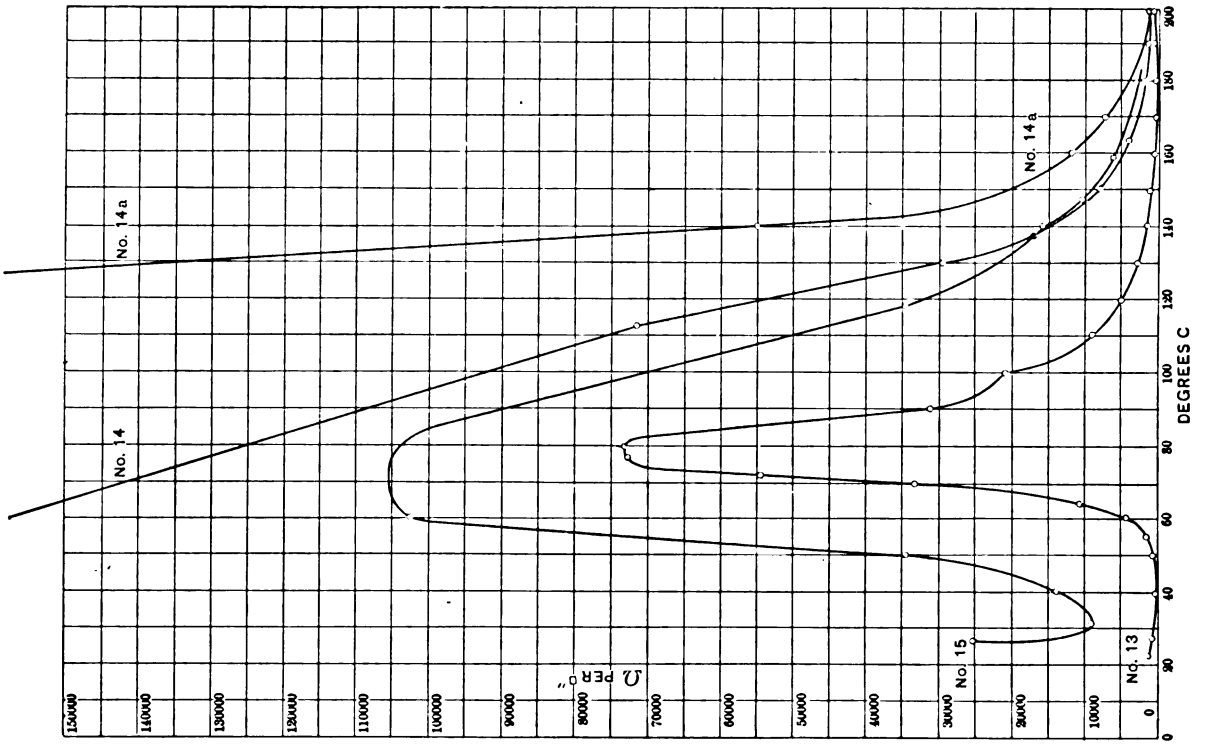

Fig. 4.

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Now the specimen is allowed to stand for exactly five days freely exposed to the moisture of the atmosphere, it being situated in a room near a window which is left open a considerable portion of the time, thus subjecting the specimen to conditions of atmosphere similar to those occurring in a station or factory.

The weather during the five days was unusually damp. A number of severe rain storms occurred, thus giving the specimen an extremely good opportunity to absorb moisture. At the end of this time a test was made, from which curve No. 12 was derived.

The object of this test is to see if, after exposure to moisture, the material will return to its original condition. By a glance at the curve thus obtained it will be seen that this actually takes place.

Let us now compare the eight curves. Curve 5 represents the original resistance variation of the material. Curve 6 shows the increased initial resistance on cooling, the specimen having been protected from moisture in the meantime. Curve 7 shows the return to the original condition on absorption of moisture. Curve 8, the higher value of the resistance curve when the specimen has been kept at 80° C. for three and one-half hours and then allowed to cool, but not exposed to moisture. Curve 9 shows that the heating up to 80° C. has practically no effect on the resistance after the moisture has been driven out and not allowed to return. Curve 10 shows the condition into which the specimen was thrown when cooled while exposed to the atmosphere. Curve 11 indicates that the moisture had again been practically all expelled and therefore the heat produced no change in the resistance. Curve 12 shows that the specimen, having been freely exposed to moisture, has returned to almost its original condition.

In all these tests the resistance remained constant during the entire time that the temperature was kept constant. On examination, the specimen was found to be practically unchanged in appearance, mechanical strength or other qualities. One might therefore conclude, on inspection of the various curves in connection with these experiments, that the action which takes place in a fibre insulating material when heated up to about 80° C. merely depends upon the amount of moisture contained in the material at the time at which each measurement is made.

Question No. 4 may be answered by reference to the curves obtained from the three tests on one piece of insulating material wound with four layers of No. 26 B. & S. bare copper wire. Area of insulation under test was 4.125 square inches, and the thickness was .009 inch.

Curve 13 is the resistance curve for the first heating from 20° C. to 200° C.

The descending portion of the curve between 23° C. and 40° C. is probably due to the coalescing of the moisture within the material; that portion between 40° C. and 80° C. shows the rise in resistance due to the expulsion of the moisture and the remainder the negative resistance coefficient which insulators usually possess.

This test being completed, the specimen was allowed to stand undisturbed and protected from moisture for twenty-four hours. Upon reheating, Curve 14 was then obtained. This shows the rapid drop from the enormous resistance acquired by the material on cooling from the previous test.

While the specimen was cooling from the heat applied in test 14, frequent measurements were made, resulting in curve (14*a*.), which shows the rise to a still higher resistance than before. At 100° C. the resistance was too great to be measured by the apparatus at hand.

Now the specimen was allowed to stand undisturbed for thirty-six hours, during which time the air in the apparatus was kept moist. Curve 15 was then obtained on repetition of the test, showing that the material when repeatedly heated to 200° C. still retains its property of absorbing moisture, and the effect upon its insulation resistance is not as great as would be expected. But it should be noted that this high temperature of 200° C. greatly injures the mechanical strength of the insulating material.

From the foregoing we may derive the following general conclusions:

a. The presence of brass in the apparatus does not affect the shape and position of the curve.

b. The difference in the curves depends solely upon the amount of moisture contained in the material and its opportunity of escape.

c. Every time the specimen cools the resistance increases to a value much above any resistance that it possessed before, provided it is kept from absorbing moisture.

It is impossible to determine the limit of this action with the present apparatus. But all the curves, particularly Nos. 5 to 13, clearly show this stepping-up effect, which is practically the same as the well-known result obtained by baking insulating materials.

W. C. VOSBURGH MANUFACTURING COMPANY, LIMITED.

The W. C. Vosburgh Manufacturing Company, Limited, Brooklyn, New York, beg to announce to the trade and the public in general that on and after August 1st, 1898, the Chicago General Fixture Company, 169 Adams street, Chicago, Ill., will act as the Western Selling Agents for the W. C. Vosburgh Manufacturing Company, Limited, in the territory formerly covered by them from Chicago.

The Chicago General Fixture Company will be in a position to sell the goods manafactured by the W. C. Vosburgh Manufacturing Co., Limited, namely: Gas, Electric and Combination Fixtures, on the same terms and prices as bought direct of the Vosburgh Company, and will have if a complete line of latest styles on exhibition.

Mr. Nate L. Maher, who has visited the trade for many years, will continue to do so for the Chicago General Fixture Company, and in the interest of the W. C. Vosburgh Manufacturing Co., Limited.

W. C. Vosburgh Manufacturing Co., Limited,
H. C. BECK, President.

CANADIAN LETTER.

ELECTRICAL NEWS.

Brantford, Ont.—The fire and light company have abandoned the proposal to install a municipal lighting plant, and have recommended that a street lighting contract be entered into with the Brantford Electric and Operating Co.

Lucan, Ont.—Dr. Shaw is making arrangements for building telephone lines to some of the neighboring villages. We understand that a line will first be built to Southgate in London township and afterwards to Saintsbury and Mooresville.

Orillia, Ont.—Tenders are invited for the street lighting plant, an incandescent plant, power service and steam plant. Particulars from town clerk, or R. J. Parke, consulting engineer, Toronto.

Charlottetown, P. E. I.—The Charlottetown Light & Power Co. was granted incorporation at the last session of Parliament.

Shawville, Que.—A joint stock company is being formed for the purpose of constructing electric light and water works systems.

‡ Transactions, Vol. XIII., page 233.

§ Transactions, Vol. XIII., page 239.

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THE ENDOWMENT OF COLLEGES OF ENGINEERING.

The wealthier class of this country are readily responding to the universal demand for greater educational facilities. They add college after college to the increasing list, endowing each with money sufficient to keep it alive and prosperous. It has, in fact, been the ambition of some of our greatest philanthropists from the very days of childhood to rear an edifice within whose walls educating influences would exert to the full their beneficial effect upon the generation passing in and out in an endless stream. Princely gifts have been made by the millionaires of this land in the erection and endowment of engineering institutions for the American public. Mr. Philip A. Armour established the Armour Institute of Technology at Chicago by giving it as a foundation $1,000,000.00 cash. To this he has recently added $500,000.00 more. This institution has 1,100 students enrolled, and, under the tutorship of Prof. Wilbur M. Stine, has developed one of the finest courses in electrical engineering to be found on this continent.

The giving of one million and a half dollars by an individual for educational purposes is in this case equivalent to a great national service. From a humanitarian standpoint, its far-reaching results upon society and the world can hardly be estimated. To remove the famine from India or bring immediate relief to the reconcentrados of Cuba is not a greater deed than this. To allay pain, hunger and thirst in a multitude of suffering wretches deserves and does receive world-wide applause, but, judged from the standpoint of time, it is to be expected, as such things will recur until poverty has succumbed, with its host of evil followers, to the influence of an elevating civilization. It is true that in the acquirement of wealth gladiatorial combats occur and men ride rough-shod over each other, but in its disbursement they seem at times gifted with a lofty inspiration.

The creation and endowment of colleges of engineering or other great public institutions will shed a lustre on the life of the donor sufficient to bring out with startling prominence all qualities of goodness. The Vanderbilts, Astors, Peter Cooper, Roosevelts, Stevens and Armours are names that will be remembered in the history of progressive civilization.

THE BESSEMER PROCESS AND ITS INFLUENCE UPON ELECTRICAL MANUFACTURING.

The technical value of a discovery is always the basis and cause of its commercial success. All great inventions exercise a far-reaching influence over industries directly dependent upon the discovery, and frequently upon industries still inchoate, the development of which is largely attributable to a newer application of the same.

The efforts, failures, and, finally, the brilliant success of Bessemer firmly established his reputation as a genius of high order, and brought into existence a process of untold value to the arts and sciences. The Bessemer process of turning pig iron into steel has been of the utmost benefit to manufacturing electricians.

The modern dynamo possesses a framework of mild steel. Its present size and state would be difficult to utilize and expensive to produce were cast and wrought iron still exclusively used. But by the development of this refining process instituted by Bessemer mild steel is produced in large quantities at a low price, possessing magnetic qualifications that make it compare most favorably with wrought iron. Some concerns using drop forgings of wrought iron found that the expense of constructing large machines in this manner was so great as to prohibit the further extension of their business along these lines. A cast iron machine was practically out of the question on account of its great size and weight, power for power, in comparison with one of wrought iron. The use of cast steel was then seriously considered, and it was found that it answered the purpose almost as well as wrought iron.

A square inch of cast iron will carry about one-half as many lines of force as a square inch of wrought iron. A square inch of mild steel will carry from within ten to fifteen per cent. of the lines of force of wrought iron without involving the use of heavy magneto-motive forces.

This demand on the part of electrical manufacturers for mild steel has added considerably to the activity displayed in that field of work by producers of the same. Steel has displaced cast iron of late on so many occasions that it seems likely to entirely supersede it in the next century and be exclusively employed for all kinds of engineering work where reliability and strength are important factors of consideration.

Lindsay, Ont.—The telegraph and electric light company will probably be asked to lay their wires underground.

Woodstock, N. B.—Improvements are to be made to the fire alarm system, including four miles of iron or copper wire.

Iroquois, Ont.—A proposition to furnish electric light has been made by Mr. Keefe.

Barrie, Ont.—The town will install an up-to-date fire alarm system.

Thorold, Ont.—The rate-payers will be asked to sanction a loan of $7,000 to extend the electric light plant.

Maniwaki, Que.—An electric plant will likely be installed for public and private lighting.

Wallaceburg, Ont.—The local electric light company have decided to install an incandescent plant within eight months.

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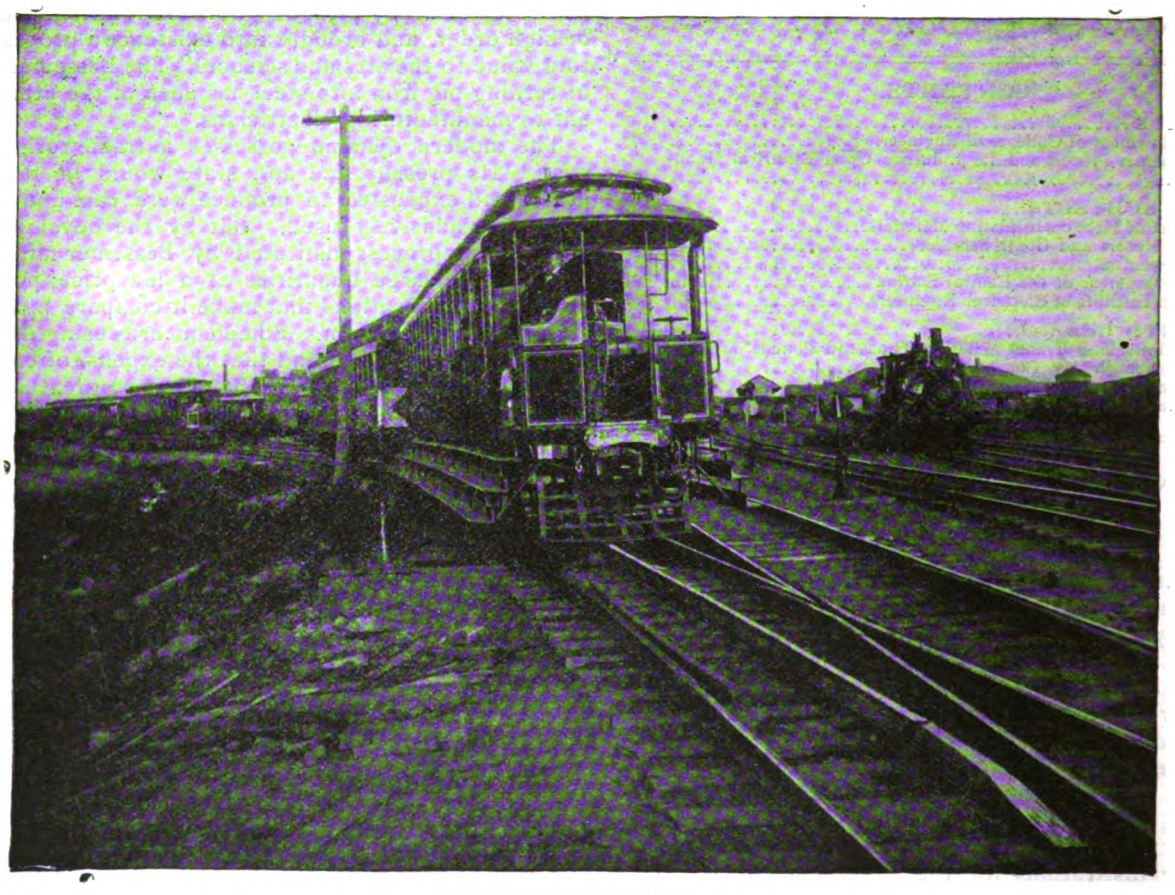
RAILWAY MOTORS AND CONTROLLERS.

(Continued.)

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

The use of motors for track service is limited to those of the series type. A series motor possesses advantages over the shunt that both experience and theory indicate. The current flowing through a series motor passes from brush to brush via armature and field. The speed and pull of the armature can be changed at will by varying the pressure applied to the armature and its current and field.



Third Rail Car Equipment.

The pulling power of any armature depends upon the

(1) Current in the armature.
(2) Strength of field.

The series motor is naturally adapted by its construction to an easy system of regulation. Not only can the current be varied outside by having a rheostat in series with the motor, but the magnet coils can likewise act in this capacity by being subdivided. A series motor connected to a rheostat and having commutated or subdivided field coils can be regulated both in speed and power by these means.

A trolley car is usually equipped with two motors. They are both series motors with commutated field coils. A small rheostat is in series with the pair. To vary the speed and pull of the car an automatic switching device called a controller is used.

Function of a Controller.—When the car is at rest the rheostat and both motors are in series. To start the car and put it through its different speeds, the controller, which consists of a cylindrical vertical commutator, is revolved. The general result is as follows:

(1) The rheostat and two motors in series.
(2) The two motors thrown in multiple.
(3) Subdivided fields thrown into multiple.

To each of these general processes there are subdivisions; that is, the rheostat contains steps which regulate to some extent—the motors may be thrown in multiple, or their fields and armatures separately, and in addition different combinations may be made of the commutated fields. The practical result of all these changes is to increase the current flowing through the motors by successive stages until the pressure and current is at a maximum.

The heaviness of motor cars has necessitated the use of strong steel rails and a secure bond. The cars used are not very different from the old horse-car style, except that they are better furnished, more capacious and in every respect more comfortable. Both station, track, car and motors are a source of expense to the company. The station has machinery which depreciates; the track requires many repairs unless well put down, and even then the rails wear out; the motors have armatures which constantly burn out and the cars become scratched and shabby from daily use.

Trolley lines running over hilly ground are apt to incur more expense from repairs than those installed on more level ground. The reason for this is traced to the greater strain upon the motors when climbing hills. The work the motor performs is divisible into two parts—that of advancing and that of lifting itself the height of the hill. In certain localities it seems evident that a cable system would be best; that is, a very hilly district. Block electric, open conduit and storage battery systems are occasionally heard of. In New York city, perhaps, the conduit system is receiving the best trial of all. Several of our largest railroads are about to permanently adopt electric cars for special purposes; the B. & O. being the most prominent of all.

QUESTIONS FOR REVIEW.

(1) What type of motor is exclusively used for traction purposes?

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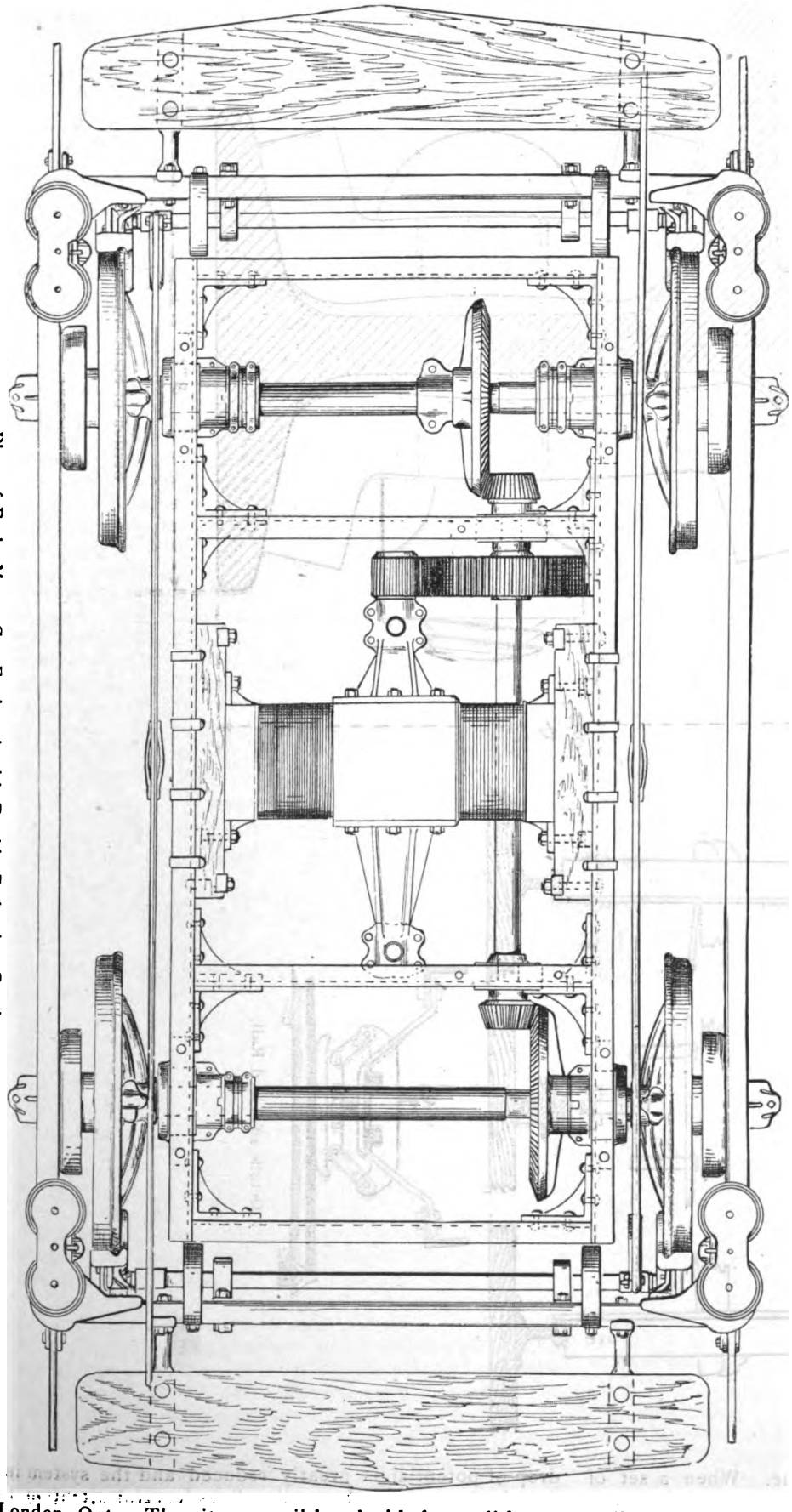
(2) Upon what elements does the pulling power of an armature depend?

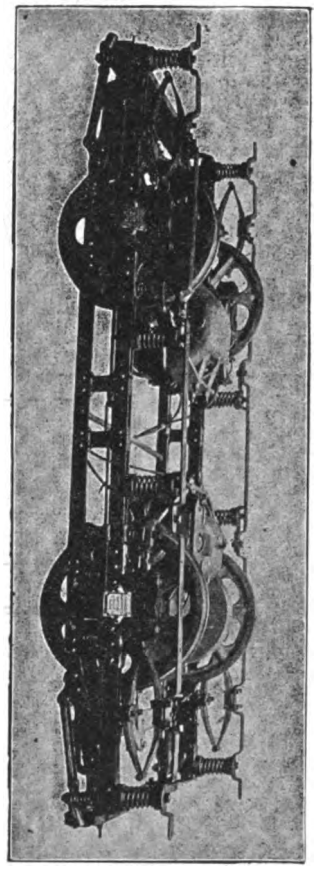
(3) How is a series motor regulated?

(4) What is the function of a controller?

(5) How does the controller effect changes in the speed and torque of the motor?



Plan of Early Motor Car Equipped with Double Reduction Gearing.



Modern Motor Truck.

London, Ont.—The city council has decided to call for tenders for a municipal electric light plant.

Conclusion of Article on Electric Railways (page 23) with Questions for Review.

DROP OF POTENTIAL.

It is necessary to appreciate the fact that the loss from leakage and the drop of potential seriously interferes with the efficiency and growth of a line. The leakage may be reduced by careful insulation, but the loss of pressure

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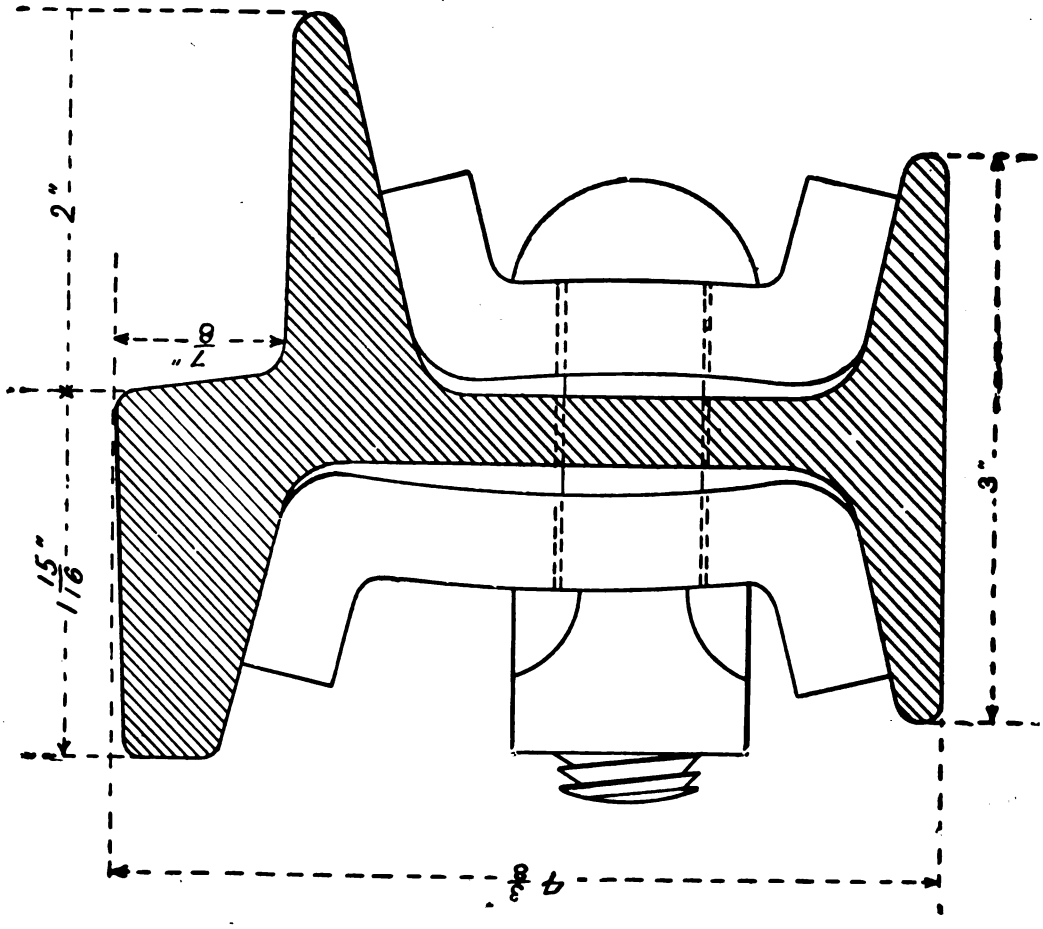
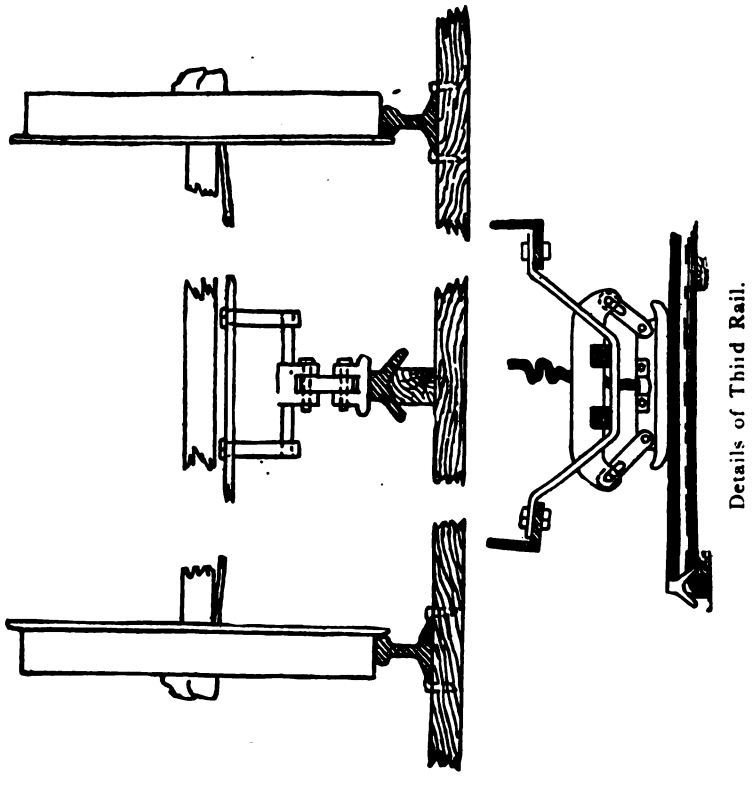
only by a successful and necessarily practical method of joining the parts entering into the circuit. The circuit in an open conduit system is two continuous copper wires or something similar reinforced by a system of feeders, that is, auxiliary lines leading from the dynamo room or station to different parts of the line. When a set of cars takes current simultaneously from the circuit a heavy flow of current ensues. The drop of potential, calculated by the rule—drop equals current multiplied by resistance—may vary from 50 to 150 volts or more. In trolley lines the tracks, being part of the circuit, must be electrically joined or bonded together. The overhead line or trolley wire is the remainder of the circuit. By having the tracks or rails welded or at least carefully joined the drop of potential is greatly reduced and the system infinitely improved. In trolley lines careful attention to these points will mean a saving of thousands of dollars in installation and running.



Section of Standard Rail.



Details of Third Rail.

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MAX LOEWENTHAL, E. E., ASSOCIATE EDITOR OF THE ELECTRICAL ENGINEER.

We take pleasure in noting that the editorial staff of our contemporary, "The Electrical Engineer," has been added to in the person of Max Loewenthal, E. E. Mr. Loewenthal deserves great credit for his persistent efforts in striving to reach the goal of his desire. His ambition to be a journalist is strictly in accord with his abilities in that direction. They go hand in hand, as it were, and thus open up for him a future which gives great promise to his career as a technical journalist. Mr. Loewenthal was born in Oldenburg, Germany, in 1874. He graduated from the Hebrew Technical Institute first in his class. He served an apprenticeship in the testing department of the Western Electric Company under Mr. Geo. A. Hamilton and subsequently took charge of a similar department of the Schuyler Electric Company, in Middleton, Conn., then under the management of E. R. Knowles, the chief electrician. He entered Columbia University, School of Mines, in 1893, and graduated with the degree of electrical engineer. While taking his collegiate course he edited a monthly called "The Technical Journal," took out several patents and wrote for some well known scientific papers. He is a member of the New York Electrical Society and associate member of the American Institute of Electrical Engineers. We believe that Mr. Loewenthal is working along the lines of least resistance in entering a field of work so congenial to his training and tastes. His conscientious labors will certainly bring successes gratifying to himself and to the numerous friends interested in his welfare.

(Continued from page 80.)

QUESTIONS FOR REVIEW.

(1) How many systems of railroading exist?

(2) What are the objections to a storage battery system?

(3) How does a conduit road operate?

(4) What is bonding?

(5) By what means is drop remedied?

THE DEVELOPMENT OF THE CENTRAL STATION.

BY SAMUEL INSULL.

(Continued from page 62.)

Lord Kelvin, commenting on Dr. Siemens' remarks of November 15, 1882, before a commission taking evidence with relation to the Edison feeder patent, said:

"There is not a word here of the necessity to secure against too great drop of electric potential between the dynamo and the lamps, or too great differences of drop between the different lamps of the system, and the narrow limitation of the area insisted upon shows that Dr. Siemens had no idea of Edison's solution of the problem, and thought only of overcoming the difficulty by enormously massive copper conductors with branches diverging from them to the points of consumption. From his earliest commencement as an inventor and engineer, Siemens had been occupied with water and gas. His first invention was a water-meter, and it is not probable that anyone in the years 1879–80 knew better than he did of the difficulties met with in the distribution of water and gas and of the methods which had been practically used or proposed for overcoming them."

Again, referring to this same subject, Sir William Thomson said:

"About that time or a little later, one of our first electrical engineers, Mr. Crompton, who has, in fact, been the first to introduce successfully and on a large scale, lighting from a central station in London, told me that he was obliged to use larger copper conductors than would be required merely in accordance with my principle for economy, in order to avoid so great a drop in potential as would be inconsistent with the good working of the lamps. At that time he had no idea of the feeder system, which he has since adopted with marked success in the Kensington-Knightsbridge electric lighting. Siemens' solution was not augmenting the size of the conductors above that calculated from the economic law, but to limit the size of the station supplied. Neither this nor the solution first proposed by Crompton is satisfactory in respect to the practical demands for the electric lighting of towns. Edison's feeder system is now universally admitted to be satisfactory to a very remarkable degree. I am asked why did not some one else invent it. The only answer to this, the last part of the question that I can think of, is that no one else was Edison."

I personally well remember Sir William Thomson's visit to the Pearl Street station in New York, in 1884, when he saw the Edison feeder system first in operation, and the great interest that he exhibited in studying it, and his admiration for the work accomplished by Mr. Edison in this connection.

I have thought it necessary to thus quote at length some of the leading English authorities on electrical matters, as I thought it would be better in claiming for an American the conception of the true basis of electrical distribution for light and power purposes, to give you the opinion and views on the matter of distribution of our "kith beyond the sea" rather than to quote the views of American scientists who might possibly be considered more partial to the work of their own countryman.

It is often said that the principles of constant potential multiple are distribution and the use of feeders to maintain an equal and economical distribution of pressure are self-evident propositions, following the lines of gas and water distribution; but when you have such high authorities as Conrad Cooke, in 1879, failing to recognize any of these necessities, of Mr. Swan in 1880 only recognizing the principles of multiple arc, and in 1882 failing to recognize the importance and far-reaching results of the feeder system, and Dr. Siemens as late as November, 1882, two months after a central station was in operation in New York city, adopting almost the same views as Mr. Swan, you cannot wonder at Lord Kelvin answering the question as to why someone else did not invent the feeder system by saying "The only answer to this, that I can think of, is that no one else was Edison."

It would seem to me, with such authorities, that it is not unreasonable to claim that the development of the central station and distribution system connected therewith dates from Mr. Edison's work at Menlo Park. Mr. Edison had been engaged during the early '70s, first as a telegraph operator in the Western Union service, and later working on the gold indicators in the gold-room in New street, New York, during the stirring period of speculation in the precious metal which culminated on Black Friday in 1873. Prof. C. C. Law, now connected with the University of Missouri, had, I believe, charge of the indicating instruments, and it is a matter of some interest to record the fact that the first work Mr. Edison did of an inventive character which yielded him a financial return was in connection with and while he was at work on the gold indicators in question. Subsequently he was

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employed in the interest of what is now the Western Union Telegraph Company in improving the now universally used stock-ticker. This work was followed by brilliant and successful work in connection with the duplex and quadruplex and automatic systems of telegraphy, and the invention of the phonograph and that part of the telphone now generally used for transmitting puposes and known as the carbon transmitter. His attention to the possibilites of what is popularly called the subdivision of the electric light was probably the result of a visit he paid to Mr. William Wallace at Ansonia in the fall of 1878, where he saw some experiments on dynamo machines, and on his return to Menlo Park he started his experiments on a system of electric light and power, which culminated in the successful starting of the first central station, in the lower portion of New York city, in September, 1882.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the meeting of the Executive Committee, June 24th, Mr. C. O. Mailloux, of New York, was elected a Vice-President of the Institute to fill the vacancy caused by the previous election of Dr. A. E. Kennelly to the Presidency. Mr. Robert N. Baylis was also appointed a member of the Board of Examiners, succeeding the late Dr. Chas. E. Emery.

The following Associate Members were elected:

Walter Cummings Allen, inspector of electric lighting, Government of District of Columbia, District Building, Washington, D. C.

Albert H. Armstrong, electrical engineer, General Electric Co., Schenectady, N. Y.

George A. Damon, with B. J. Arnold, Electrical Engineer, 1541 Marquette Building, Chicago, Ill.

Frank H. Dexter, student Cornell University; residence, 51 Huestis street, Ithaca, N. Y.

P. M. Downing, Supt. Electrical Dept. Blue Lakes Water Co., Blue Lakes City, via Jackson, Cal.

Joseph Lyons, Patent Solicitor, with Gustav Bissing, 908 G street, Washington, D. C.

The following Associate Members were transferred:

Alfred A. Thresher, electrical engineer and proprietor Thresher Electric Co., Dayton, O.

William B. Jackson, New York and Staten Island Electric Co., West New Brighton, N. Y.

Paul M. Lincoln, Electrical Superintendent Cataract Construction Co., Niagara Falls, N. Y.

Thorburn Reid, Consulting Electrical Engineer, 120 Liberty street, New York City.

Philip Green Gossler, Electrical Engineer, Royal Electric Co., Montreal, P. Q.

Theodore E. Theberath, Pacific Coast Engineer, Stanley Electric Co., San Francisco, Cal.

Frederick M. Pedersen, Assistant Electrical Engineer, Crocker-Wheeler Electric Co., New York City.

Will K. Dunlap, Electrical Engineer, Westinghouse E. and M. Co., Niagara Falls, N. Y.

CANADIAN LETTER.

ELECTRIC RAILWAYS.

Montreal, Que.—The Railway Committee of the Privy Council at Ottawa considered the bills for electric railways in the neighborhood of Montreal. A charter was granted to the North Shore Electric Railway Co., which proposes to build an electric railway from Three Rivers along the northern shore of the St. Lawrence River. The Montreal & Southern Counties Railway Co. was given power to extend their operations to the counties of Beauharnois, Chateauguay, Huntingdon and Napierville. The promoter of both of these undertakings is Mr. A. J. Corriveau.

London, Ont.—The scheme for an electric railway from London to Stratford, Arcona and Thedford, connecting the C. P. R. and the G. T. R., is making satisfactory progress.

Waterloo, Ont.—The rate-payers have sanctioned the by-law granting a bonus of $12,000 to the Galt and Preston Electric Railway for the extension of its road.

La Patrie, Que.—There is talk of building an electric railway between this town and Scotstown.

St. Catharines, Ont.—A by-law authorizing the construction of an electric railway between this city and Port Dalhousie has received its first reading in Council.

Chicoutimi, Que.—Mr. Picher is reported to have had plans prepared for an electric railway to be built here.

Hamilton, Ont.—The promoters of the Hamilton, Chedoke and Ancaster Electric Railway state that the line will be constructed to Hamilton provided the Council buys the Beckett mountain drive.

Quebec, Que.—The Quebec, Montmorency & Charlevoix Railway Co. convert the road between Quebec and Cape Tourmento into an electric line and a branch line to Montmorency Falls to be operated by electricity.

Toronto, Ont.—The Toronto Street Railway Company have had plans prepared for several proposed extensions, including a second line down Station street. This line will be built as soon as the bridge over the Yonge street track is built by the city. This bridge is estimated to cost $200,000.

J. ALCIDE CHAUSSE.

Lansing, Mich.—Citizens' Long Distance Telephone Co. has been incorporated with a capital stock of $5,000.

Malvern, Ark.—C. W. Turner will construct an electric plant. Bids for same are being invited until May 31.

Bivalve, Md.—John W. P. Insley is endeavoring to organize a company for the establishment of a telephone system extending from Salisbury to Nanticoke, a distance of thirty-five miles.

Neosho, Mo.—The Neosho Electric Light Co. will probably erect a new steam-power plant, abandoning its present water power.

Gallatin, Tenn.—The Mayor may be addressed for information regarding electric light plant.

Frankfort, Tenn.—The Cumberland Telephone and Telegraph Co. and the Great Southern Telephone Co. have consolidated. Capital stock, $3,000,000.

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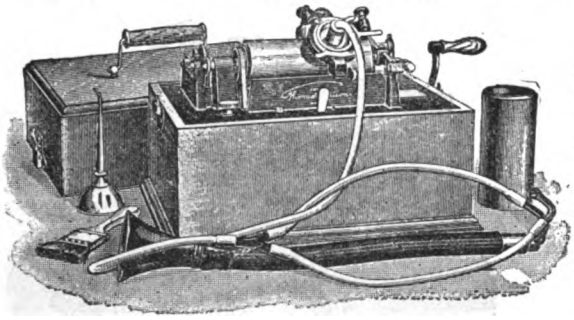
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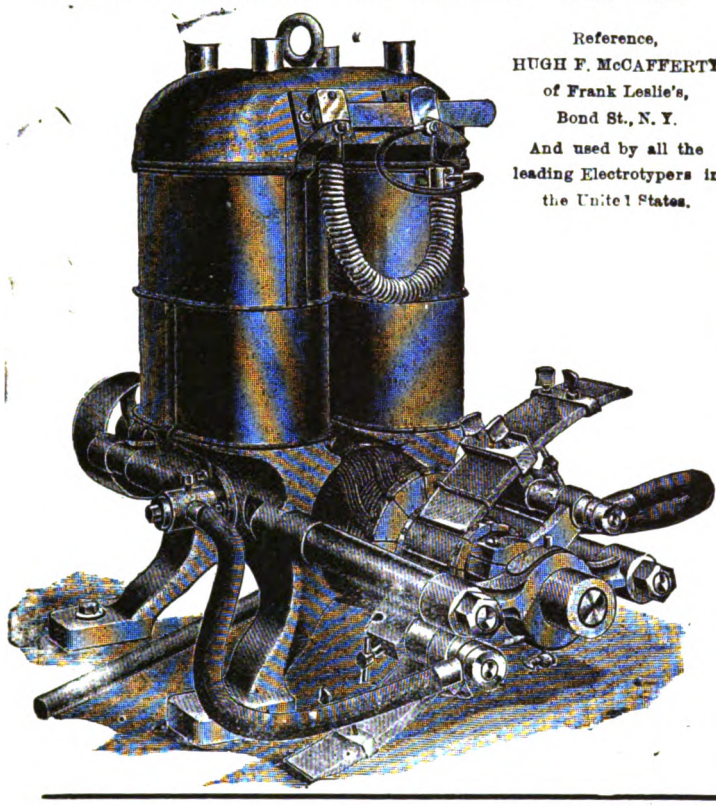

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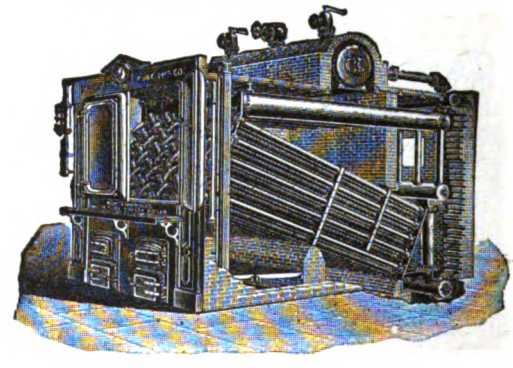

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The Electrical Age.

VOL. XXII—No. 7 NEW YORK, AUGUST 13, 1898 WHOLE No. 587

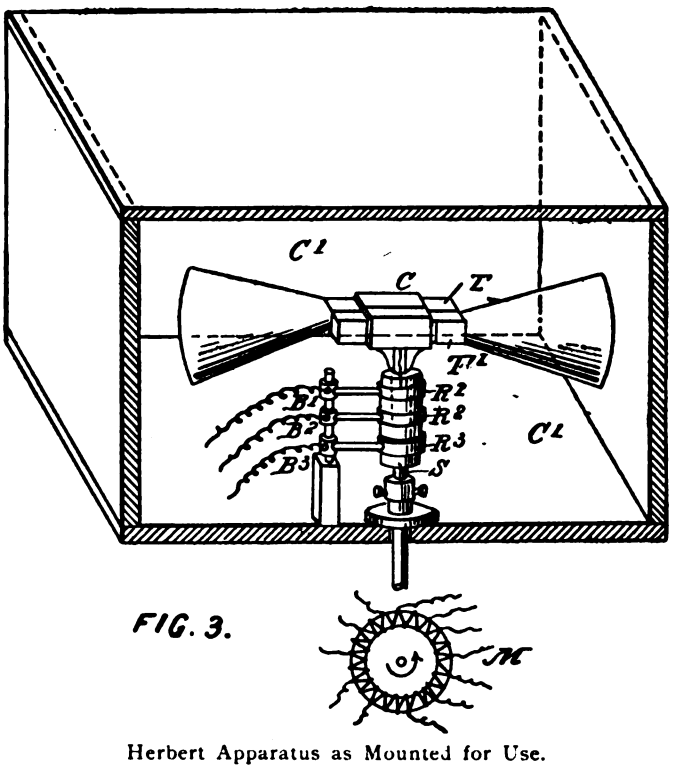
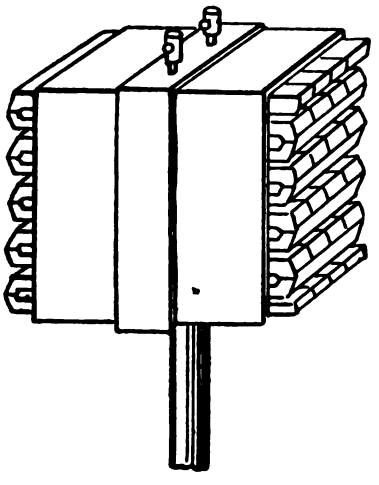


FIG. 3.

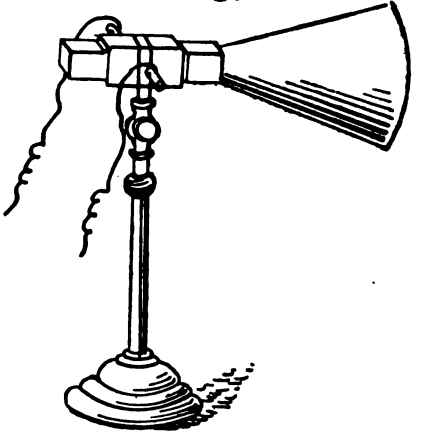
Herbert Apparatus as Mounted for Use.

FIG. 1.



Thermopile.

FIG. 2.



Thermopile Detector.

MEANS FOR DETECTING THE PRESENCE OF A VESSEL OR AN ICEBERG; HOW THEIR MOVEMENTS MAY BE FOLLOWED.

The recent Bourgogne disaster, connected with such heavy loss of life, such fearful dramatic scenes, where egotism was predominating to such an extent that barbarous means were resorted to in butchering and annihilating the weaker element, has caused a deep and everlasting impression upon its survivors, upon everybody endowed with a fellow-feeling.

The average person lacks coolness of mind in such critical moments, and in losing all self-control shakes that of those then unaffected. It seems to me that travellers should be made familiar with the safety appliances on board a steamer, and I venture to express the hope that the Bourgogne disaster will not only cause the different navigation companies to give to their patrons practical lessons in using and applying such expedients, but also such further information as may be of benefit to them in case of accidents. As to the matter of life-boats, improvements seem highly desirable and particularly to quick and efficient means for launching them. Many lives were lost just on account of this deficiency. It should be made compulsory for each vessel to have a total carrying capacity of their life-boats exceeding by

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10 or 20 per cent. the maximum number of passengers carried.

This Bourgogne disaster has stimulated within me the desire of finding some such suitable means whereby collisions at sea may be avoided.

Before entering into a discussion of these, it may be in order to mention a few methods of signalling now in use. Among the auricular signals we have with an approximate hearing distance in miles, the following:

The air siren, . .	10 to 12 miles.
The steam siren, . .	8 " 10 "
The trumpet, . .	6 "
The bell, . . .	1 "

This hearing distance is however not constant and depends upon many conditions referred to further below.

For receiving the sounds the eophone, topophone or similar instruments have been employed with more or less success. The object of these instruments being to furnish a means whereby to determine the direction from which the sound proceeds. The eophone consists of two bell-shaped receivers separated by a central diaphragm, the further end tapering down and being connected with ear tubes. The whole is mounted in a suitable manner, whereby it is possible to point the open ends in any direction desired. If the receivers point in the direction of the sound, then each ear will perceive it with the same intensity.

Under existing conditions it is necessary that both vessels be active, not only in giving signals, but also in "attempting" to intercept them. The safety of a vessel consequently not only rests with its own crew, but largely depends upon the watchfulness of the other vessels. A good deal of blind confidence is therefore placed in any stranger who may come along; it is not this alone which makes navigation dangerous during a heavy fog, it is made much more so on account of coinciding circumstances which as yet are not fully understood. At times it is impossible to perceive the phonorous signals when the steamer is near by, while the signal was plainly heard from some greater distance. As to the cause of this surprising interruption (seeming) in the propagation of sounds, investigations have been carried on by the United States, Germany and France. The investigations made by Major Livermore, in compliance with the U. S. Admirality, have thrown some light upon this subject. It has been deduced that obstructions to sound or an irregular formation of the coast not only materially affect the strength but also the propagation of the same. Obstructions behind the source of sounds will reinforce them in a similar manner as a screen will reflect the light. Rain and snow will have a great influence upon the direction of the sound.

It has been observed that under certain conditions a sound could not be heard near the surface of the water, while it was heard plainly some distance above it. In one experiment Major Livermore's vessel had been placed in such a position that the blowing of whistles, even the shooting of a cannon was heard at one end of the vessel most distinctly, while it was impossible to detect any sound at the other end, although the steam or smoke could be seen to arise. It seems therefore that under certain conditions sound waves may be projected upward, to descend again at some distance and finally take up their original direction. No doubt this remarkable interruption has caused many accidents.

At the first thought it seems that wireless telegraphy would meet all requirements. Reflecting upon this will soon convince us that each and every vessel afloat would have to be equipped with a complete set of apparatus. Even if their use were made compulsory, then again would the safety of a vessel largely be dependent upon the other vessels in a similar manner, as outlined above.

Although the introduction of this kind of apparatus would make navigation safer, the location and movements of other vessels could nevertheless not be determined.

Besides the vessels, there are icebergs and floating wrecks.

Taking all in all it is desirable to find a means which will indicate the nearness or approach of any object.

It is well known that any object, when its temperature is higher or lower than that of the atmosphere surrounding the same, will either send forth heat radiations, or else, in the other case, absorb heat from its surrounding medium. In the winter we clothe ourselves to keep warm; in other words, we surround ourselves with a poor heat conductor so as to diminish the heat radiations from our body to the atmosphere.

If we can construct an apparatus which is acted upon by such heat radiations, and if the apparatus be of such sensitiveness that it will intercept and indicate them, even if they be exceedingly weak, then we have a means which may be advantageously employed in navigation. As soon as we can intercept the radiations sent forth from a vessel we need not depend upon our ear or eye to locate the same.

A modification of the thermopile or the radiophone may be employed in connection with this problem.

A few remarks pertaining to these may be of interest. Seebeck, is 1832, discovered that an electric current is set up in a closed circuit made up of different metals as long as the junctions would be maintained at different temperatures. The best effects have been subsequently obtained by the use of antimony and bismuth.

Fig. I. shows the assembly of suitable metal strips, surrounded by an insulating casing, forming the thermopile. The free ends of the metal strips are connected to binding posts.

Fig. II. shows such a thermopile rigidly supported and provided with a conical attachment, which is blackened on its inner surface. It serves the purpose of concentrating the radiations upon the exposed face of contact, in that way augmenting the effects.

Fig. III. shows part of an apparatus as proposed by me to the end of detecting the approach or nearness of and vessel, iceberg or obstruction. The two thermopiles, T and T1, are surrounded by an insulating casing C, any are attached to a shaft S, which may be revolved slowly. The insulated rings R1, R2, R3, serve to establish a permanent connection of the thermopiles with the brushes B1, B2, B3, from whence wires may be led to the pilot house to the observation or indicating apparatus. The thermopiles are inclosed in a suitable compartment, such as to exclude all air currents, and to afford protection from the radiations of the sun and the vessel itself. For this reason the whole is mounted on the outer side of the vessel. It may therefore be necessary to have one set of apparatus at each side of the vessel, to afford proper protection. A flat, ⊃-shaped double walled casing (not shown) surrounds the compartment C1; the outer chamber of the former is filled with alum or other heat absorbing solution, for the purpose of intercepting radiations due to the rays of the sun either striking directly or being reflected from the water, and also for intercepting those which are emitted from the vessel itself. The inner chamber may be attached to a continuous water supply, so as to remove all heat which the alum cell may have absorbed, and also to maintain the chamber C1 at a constant temperature; i. e., the temperature within the chamber should be constantly corresponding to that of the surrounding atmosphere, allowing for radiations just referred to.

Fig. IV. shows a diagram of connections. A junction of two of the free ends of the thermopiles T and T1 is led to the middle ring and thence over the brushes to the two galvanometers, G1, G2, here shown of the D'Arsonval type. The other terminals of the galvanometer coils, C1, C2, connect through adjustable resistances, XR1, XR2, and switches S1, S2, to their respective outside

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rings R1 and R2. For observation a galvanometer scale may be employed, or perhaps an automatic indicating apparatus, as shown in Fig. IV. A light aluminum arm, A, fastened to the movable galvanomerter coil, swings between two adjustable contacts, D1, D2 or D3 and D4; a local circuit, including batteries E and bells, is completed should this arm turn through a small angle. For indicating the exact position of the thermopile a large number of contrivances may be constructed. In these it should be aimed at to have a position indicator P, operated by the same current which revolves the thermopiles.

Suppose now that in foggy weather, when we cannot see, when we are in fear of being deceived by the sound, we start this apparatus and make ourselves independent of the watchfulness of other vessels.

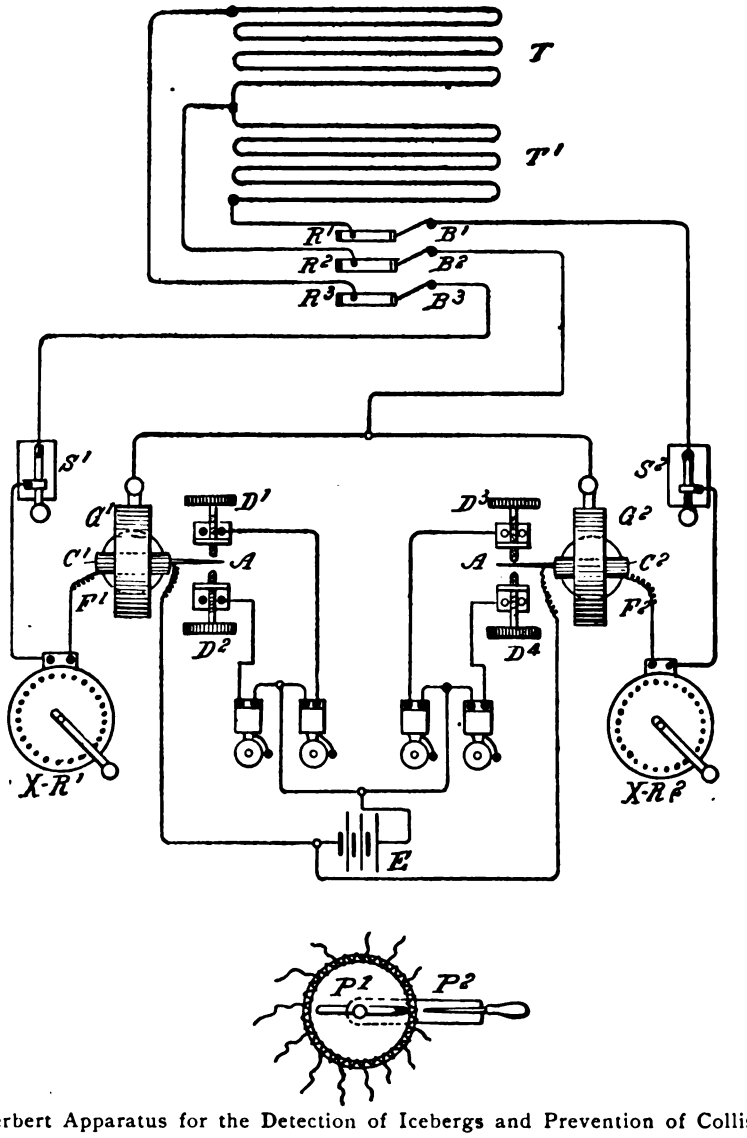
A vessel approaches—we are not aware of it—the radiations given out by the same are too weak to affect the apparatus; we come nearer each other; a stronger current is set up in one of the thermopiles at the moment it points in the direction whence the radiations proceed. Instantaneously the galvanometer coil is slightly turned, the aluminum arm makes contact and causes one of the bells to give a short ring. This happens once at every half revolution, as then the second thermopile becomes active. As the distance between the vessels diminishes the effect will naturally increase, and a contact is made covering a longer period of time. Watching the position of the slowly moving position indicator P at the moment the bell rings, and simultaneously cutting out one of the thermopiles by switch S1 or S2, will immediately give us an approximate knowledge of the direction from which the vessel is approaching us. To obtain a more accurate knowledge, the adjustable resistance may now be manipulated; it being in circuit with the galvanometer, the current from the thermopile will of course be cut down. Under normal conditions, i. e., with the resistance cut out, the bell will operate for a certain length of time, depending upon the amount of radiations sent forth from the nearing vessel, as well as the time of exposure to their influence; this again depends upon the speed of the revolving thermopiles.

The purpose of the resistance, then, is to cut down the action of the thermopile to such extent that the aluminum arm makes contact only at the instant the maximum current is being produced. As this can occur only when the thermopile points directly towards the strange vessel, its position is immediately ascertained by simply moving the contact lever until the bell gives the shortest obtainable ring.

For all ordinary purposes the observation of the slowly moving position indicator arm P will therefore be sufficient. A small adjustable pointer P2, which may be swung around the outside casing of the position indicator, may serve to fix this position.

By the increased or diminished action of the thermopiles we know whether a vessel approaches or whether it recedes; by watching the position indicator, we know whether the vessel is moving toward the right or toward

FIG. 4.



The Herbert Apparatus for the Detection of Icebergs and Prevention of Collisions.

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the left. These means, therefore, enable us not only to ascertain the presence of a vessel, but also to follow its movements; and all this is accomplished by simply adjusting the rheostat, listening to the bell, and watching the position indicator.

Safely passing the vessel we now come near an iceberg. The effect is similar as before; the current produced is, however, now flowing in the opposite direction, causing the coil to turn the opposite way, and also a different bell to give its warning signal. It is possible, therefore, to tell the nature of the obstruction, whether it be a vessel or an iceberg.

In the case of a floating wreck more difficulty is to be expected, as its temperature will not differ very much from that of the surrounding atmosphere. It may, however, be that if its entire exposed surface is in moist condition, a sufficient fall of temperature is produced to affect the apparatus, and to do likewise on account of radiations given out due to exposure to the rays of the sun. For the same reason it may also be possible to tell when nearing a coast.

The double thermopile is proposed for the purpose of increasing the action of the apparatus, as then it is possible to revolve the same at a slower speed, in that way giving a longer exposure to the radiations. At the same time the vessel is better protected. A combination of four of these would undoubtedly improve the effects considerably, as the speed may then be cut down still lower. A plurality of thermopiles suitably arranged would not require to be revolved.

The indicating apparatus, i. e., the galvanometer, should preferably be mounted so as to be free from vibration, and in a similar manner as that employed with the compass, to make it independent of the ship's motion.

Now a few remarks touching upon the radiaphone:

Berzelino, in 1817, discovered the silenium. Knox, in 1837, found that it was an electrical conductor. May discovered that its conductivity is much influenced by light. In their experiments most physicists used the galvanometer, while Bell used the telephone. Bell and Tainter subsequently constructed the photophone, its receiver consisting of metal disks insulated from each other and covered with selenium. A ray of light—reflected from a mirror diaphragm against which is spoken—after passing through suitable concentrating lenses is reflected to a distant parabolic concave mirror and thence unto a selenium cell, which is in circuit with a telephone receiver and battery. Sound was in this manner transmitted over a beam of light. Later experiments showed that sound can be transmitted more efficiently by nonlumious heat rays. Mercadier then constructed the radiophone. In this instrument soot or lamp-black is made use of, forming a bridge between the two electrodes which are in circuit with battery and telephone. In some experiments Graham Bell used a bottle or test tube, covered or filled with soot. Throwing the focussed light would on these produce a sound if the rays be of an intermittent nature.

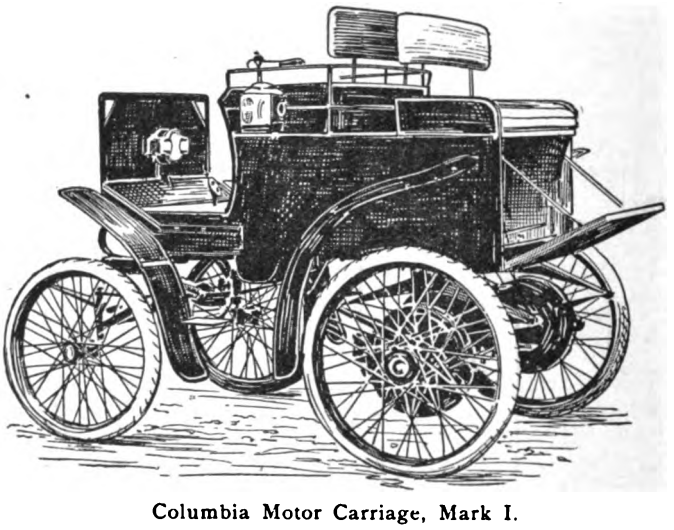
It is a fact, then, that heat rays will affect the conductivity of such radiophonic apparatus. Whether their application to the above end could be accomplished seems at this moment difficult to answer. If their sensitiveness can be brought up to that of the thermopile, and if no serious mechanical difficulties be met in maintaining the soot on the proper place, then it would become a simple matter to apply such radiophonic apparatus for the purpose stated.

My first conception of applying these means dates back to July 7, 1898. I will not commit myself in stating that such methods as outlined above are absolutely feasible under all conditions; nevertheless they appear worthy of a careful perusal, study and experiment. Certainly a large number of factors must be dealt with in the attempt of solving the problem so fascinating, interesting, and what is more, of such vital importance. The effects of warm winds, those of the Gulf stream and perhaps many others, must be considered. A true guide to the vessels, whether in peace or in war, would be welcomed by all parties concerned. Not only that accidents and consequent deaths would be almost entirely eliminated as far as collisions are concerned, but also would such travelling lose its most detrimental danger.

Seeing all the possibilities, I most heartily advance these rather incomplete ideas, and hope that the Press here as well as abroad will contribute its share in discussing the subject. I also express the hope that all those interested will not withhold their ideas, and further, that influential parties will lend their aid to bring about a realization of this problem.

HERRMANN HERBERTS.

Newark, N. J.,
225, Washington Street,
July, 1898.



Columbia Motor Carriage, Mark I.

ELECTRIC AUTOMOBILES.

The great power of the future is undoubtedly electricity, and in its many phases and forms will be found in the factory and home, driving the wheels of great machines, running trunk lines, lighting and heating our cities and finally displacing the horse from its familiar position before the dashboard of the family carriage.

Stables of the old type, those of to-day, will be rehabilitated, absolutely transformed as it were, into an estab-

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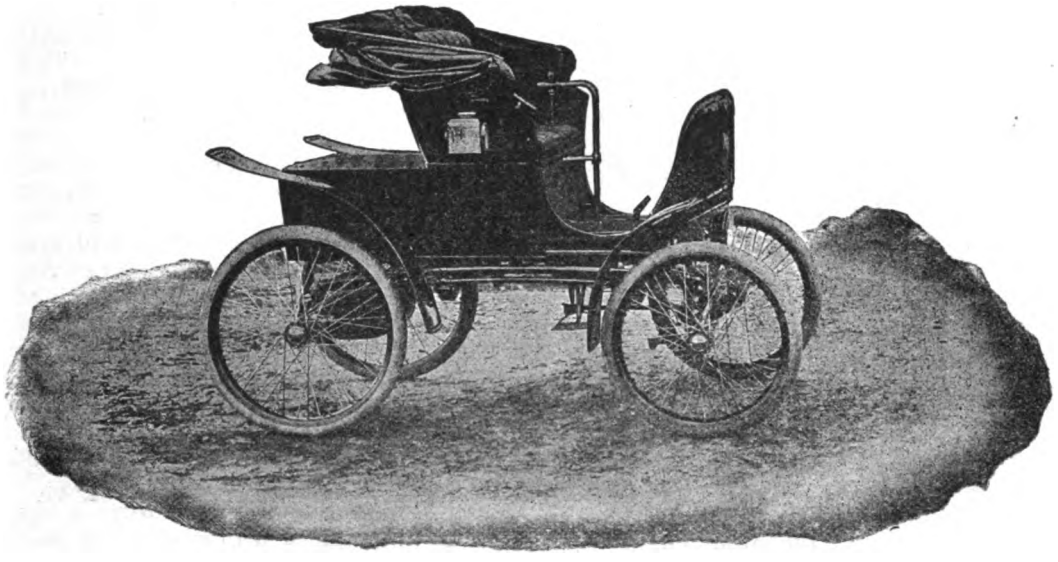
lishment equipped with every convenience for the preparation of the electric carriage for the road. In it electricity will reign supreme. Horses will no longer claim our attention for either fast driving or long distances, but in their place will be found a veritable Pegasus, an invisible and tireless giant, requiring neither whip nor reins, nothing but the touch of a button, a harness of insulated wire.

take about three hours to charge, and during that process require no further care than the attaching and detaching to and from the 110-volt circuit. One charging will carry the vehicle a distance of twenty-five miles. About five thousand trips may be made before the batteries give out, and the expense of a charge is about sixty cents. The illustration show types classed as Mark III., IV. and VI.

Mark III. carries a two-horse power motor as well as



Columbia Motor Carriage, Mark III.

The Pope Mfg. Co., of Hartford, Conn., exhibited at the recent Electrical Show one of these new carriages. As a paragon of excellence its superior qualities attracted considerable attention. We illustrate below types of the Columbia Electric Motor Carriage for the reader's benefit. It is, of course, interesting to know the answer to two most important questions—

(1st) Are electric carriages practical?

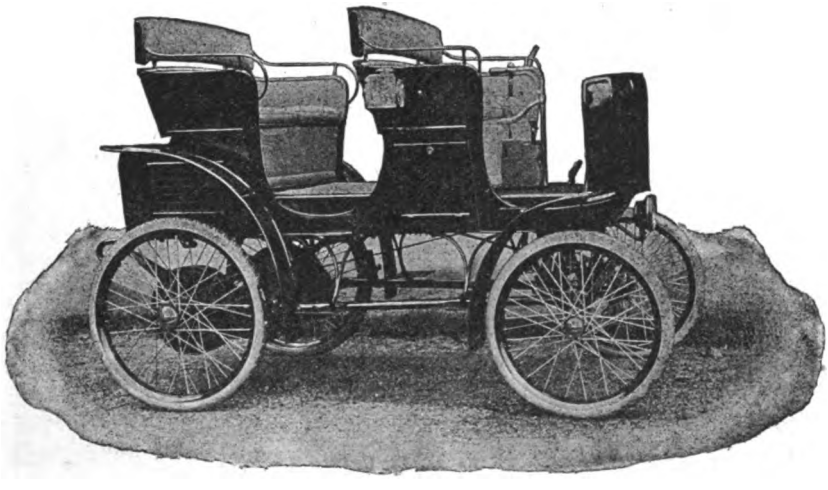
(2d) What is the cost of operating them?

To these questions may be evidently added others referring to the original cost of carriage, depreciation, weight, etc. As regards the practicability of the scheme

Mark VI. Mark IV. carries a pair of two-horse power motors so enclosed as to render them immune from dust or moisture.

With their three-inch pneumatic tires and solidly constructed wheels of high resilience as well as fine design, from an æsthetic standpoint the Columbia motor carriages are most emphatically reliable, practical and handsomely constructed.

As regards the cost of operation and wearability, they are factors that require no further discussion. The carriages themselves are priced as follows: Mark III., $2,500; Mark IV., $3,000, and Mark VI., $2,750. The renewal



Columbia Motor Carriage, Mark IV.

of operating carriages by electricity our reader should interview a European traveller on the subject. Streets in Paris, London and Berlin are filled with automobiles. They are common sights and play their part there as a familiar feature of a permanent nature.

Their practicability is not doubted there, only the character of the power employed. In this respect electricity is by tacit admission the most satisfactory form of energy to be used. In the Columbia carriages storage batteries of the lightest weight commensurate with the supply of power and efficiency required are in use. They

of the storage battery in each costs as follows: for Mark III., $375; Mark IV., $525 and Mark VI., 425.

Comparing the horse and carriage with groom, etc., from a dollar-and-cent standpoint, with the horseless carriage, it will be seen that the above figures are comparatively low; that is, the original cost of a team of horses, carriage and their care, with the first cost of a Columbia Electric Motor Carriage complete, would balance up evenly, leaving a large margin in the purchaser's favor the second year.

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THE MONTAUK MULTIPHASE CABLE.

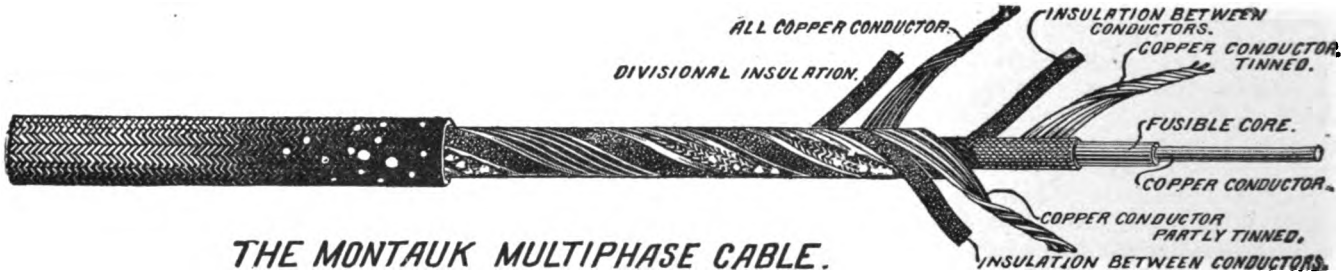
[Extract from the Williamstown "Advertiser" of Saturday, July 2, 1898. Electric Fire Alarms. Some Startling Novelties, Introduced by Mr. E. H. Kirkby.]

Yesterday afternoon a number of leading gentlemen attended Mr. E. H. Kirkby's manufactory, Nelson Place, to witness some startling effects in electric mechanism either introduced into the colony from America by Mr. Kirkby, or the results of his own researches The public of Williamstown may not be aware that Mr. Kirkby, in his own special line, is not only the leading machinist in Melbourne, but he perhaps has no equal in Australia. He does the electric alarm work for the Metropolitan Fire Brigade; has fitted up Government House, several of the large houses in Flinders Lane, the Princess Theatre, and his services have been sought to do similar important work in Sydney.

Mr. Kirkby yesterday astonished his visitors by the readiness of the various devices in his establishment to give fire alarms and to ring bells and telephone upon the slightest provocation. There would be a fortune for an illusionist show in some of this mechanism he uses. One of these is so sensitive to heat that, by merely breathing upon it, it will ring an alarm bell, but Mr. Kirkby explained that the temperature at which it worked could be regulated like the working of an alarm clock.

Mr. Kirkby has introduced the Montauk Multiphase Fire Cable into the Colony, and it was submitted to a highly satisfactory practical test for the first time in Australia yesterday. It is a most ingenious invention, and Mr. Kirkby is so satisfied with it that he has taken the responsibility of recommending it to Mr. Stein, superintendent of the Metropolitan Fire Brigade, and will introduce it to the big mercantile houses in the city. The cable can be attached to an ordinary electric bell, to a telephone and to the fire alarm. The great and peculiar property possessed by this cable is that when it is ignited it will instantly ring a fire alarm on any premises where Mr. Kirkby's automatic fire alarm is connected with it. Mr. Kirkby is convinced that if this cable had been used in Melbourne recently the great fire, at which damage to the amount of one million sterling was done, would have been avoided.

Mr. Kirkby intends to give another demonstration in the city at an early date.



THE MONTAUK MULTIPHASE CABLE.

SHOWING FUSING EFFECT AFTER CONTACT WITH DANGEROUS HEAT OR FLAME.

A NEW INCANDESCENT FILAMENT FOR ELECTRIC LIGHTS.

The German Journal for Gas Lighting of recent date contains some highly interesting information upon what is perhaps the most important new topic in the science of illumination, namely, the improved incandescent filament for electric lamps, which has just been announced by Dr. Auer Von Welsbach, the distinguished inventor of the incandescent gaslight which bears his name. It was but natural that, having perfected the device which increases so remarkably the illuminating power of gas, Dr. von Welshbach should seek to develop some similar improvement for the application of electrical currents to illuminating purposes.

This he appears, from the somewhat meagre published accounts, to have found in a filament of osmium, one of the rare metals, which, besides being the densest of all metals, is the most refractory, being infusible at any except the highest attainable temperatures. Osmium is found native as an alloy in certain ores of platinum and iridium. It is a hard, bluish-gray metal, with an atomic weight of 191.1, and the enormous specific gravity of 22.477, the heaviest substance known. Its tetroxide has a strong odor of chlorine, from which circumstance its name was originally derived

But the property which must have suggested osmium as the material of the new electrical filament was its practical infusibility, its known resistance to temperatures in which platinum and iridium volatilize and disappear. It is well known that the intensity of light emitted by an incandescent substance increases rapidly with its absolute temperature. By heating osmium in a vacuum with an electrical current strong enough to volatilize platinum, it attains a luminosity hitherto almost unknown, emitting a white light of agreeable quality and color, but of great intensity.

So far as can be inferred from what has been published, the experiments of Dr. von Welsbach go quite beyond the employment of a naked osmium filament, and include coating the metal with a refractory oxide like thoria

It has long been known that a platinum wire or filament, through which a sufficiently strong current is passed, attains a white heat and then suddenly melts. If, however, the filament be coated with a highly refractory oxide like thoria, the temperature required to melt it is greatly increased, for the reason that part of the electrical energy is withdrawn from the metal to its oxide coating and is radiated in the forms of light and heat. Precisely the same result happens when the filament coated with oxide is of osmium, instead of platinum, and the resistance of the filament is still further increased to the extent that osmium is in itself more infusible than platinum.

There is thus obtained a filament capable of sustaining a temperature and consequent intensity of illumination hitherto unachieved by such means, and it is this which forms the germ of the present invention of Dr. von Welsbach. It has been noted in his experiments that osmium used for this purpose must be almost chemically pure, and that commercial forms of that rare and costly metal require, before using, to be cleansed, as far as possible of all impurities except platinum, a small admixture of which renders the osmium more elastic without sensibly diminishing its infusibility. The whole effect of the invention, if practically applied, will be to advance in an important degree the limit of electrical energy which may be used in incandescent lighting and thus reach a new standard of economy in the production of artificial light, which is cheapest at the intensity obtainable only at high temperatures.

Osmium, according to the trade catalogne of a leading German chemist, costs $1.10 for twenty grains; so that if

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THE NATURE OF OZONE.

Ozone is a gas possessing remarkable properties. It has received attention from the greatest of our scientists and is considered by them as the most powerful oxidizing agent in existence.

The great investigator, Michael Faraday, pursued a variety of experiments with ozone, which made him in turn conclude, to use his language, "It is a powerful electromotive substance." The molecule of ozone differs from that of oxygen in being composed of a triad of oxygen atoms instead of merely two. The influence of a high potential or a powerful electrostatic stress on a stream of pure oxygen will alter the atomic combination sufficiently to transform a considerable portion into ozone.

The properties of ozone are certainly remarkable when we realize that it is essentially oxygen, and yet differs so radically from oxygen in the possession of new chemical characteristics. It seems to be oxygen compressed, as it were, and thereby developing the reactive powers from which it has derived its name. We may present as a direct proof of the effect of a force in transforming oxygen into ozone that, during this transformation, energy in the form of heat is absorbed, to such an extent that nearly 30,000 calories disappear in the production of about fifty parts of ozone.

Regarding the manufacture of ozone, from a technical standpoint, we discover that a glow or brush discharge is most effective in producing this gas. Experiments carried out with the idea of determining why atmospheric oxygen undergoes transformation have resulted in the conclusion that an electric discharge so raises the temperature of the oxygen that the transformation of it into ozone immediately ensues.

Whatever may be the nature of the new chemical recombination which occurs, ozone still remains one of the most unique gases in existence. Its hygienic value and bleaching properties are familiar to all, though not known with any degree of definiteness. A slight percentage of it in the air possesses the greatest medicinal value, stimulating the lungs and increasing the strength and beat of the pulse.

As a disinfectant it acts with remarkable power, completely annihilating active, poisonous and disease-spreading germs. For the prevention of suppuration in wounds, and the treatment of ulcers, etc., ozone has been found to be an excellent medicament.

It is surprising to realize how frequently and effectively ozone becomes of use in large cities. Of course its value is greater in the field of medicine than when applied commercially, but in either case it is generally admitted that ozone is one of the most valuable additions to the list of useful discoveries. A decided advantage in its favor is due to the fact that it may be readily manufactured even in homes or places removed from electric light wires. The exceedingly beneficial effects of ozone lead us to presume that its use will greatly increase as the field of its application enlarges. The demand for ozone has grown to such an extent that a large English corporation have undertaken to supply physicians and the commercial world with apparatus for its generation.

At present it seems as though the manufacture of carbolic acid, peroxide of hydrogen, etc., were not of more immediate importance than the manufacture of ozone. One quality which it possesses, and which should lead to its immediate adoption by municipal authorities, is the readiness with which it sterilizes water. If used for no other purpose its power of rendering a contaminated water supply harmless to the innocent residents of a large city is sufficient.

We have lived up to a period of civilization in which we realize that the preying parasite, the mighty microorganism, is known to have swept millions of the human race into oblivion.

Greater battles are now fought between men and microbe than graced the achievement of the Roman Cæsars. The physician is doing his work bravely, but the success of his efforts depends more and more upon the assistance of his readiest helpmate, the electrician.

PREVENTING COLLISIONS AT SEA.

To be clairvoyant to the approach of a vessel at sea is within the scope of an electrician's power. Recent accidents have shown the pressing necessity for some means whereby the captain of an ocean liner is in touch with objects around him. The dark nights, the foggy days, the snow-crowned icebergs looming suddenly up before him, have taught their lesson to the most careful of navigators. The day is approaching when the terror of such things will depart.

The article by Herman Herbert found in our columns, contains practical suggestions to this effect. We advise our friends to read it. The inventor of a successful scheme meeting immediate application will certainly benefit the human race as much as the unknown discoverer of the compass needle. Mr. Herbert's article indicates a close study of the situation, but as to its success, that can only be determined by trial. Even if unsuccessful, at times a device that will assist us in warding off that most awful of dangers, a collision at sea, is worthy of the most serious consideration, and its originator should be blessed for his intentions as well as his success.

Victoria, B. C.—The British Colombia Electric Railway Co. have asked for an extension for two years of the time for the completion of their railway.

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the new filament should become successful in general use, there will be a demand for a larger supply of that metal at a more moderate price.

FRANK H. MASON,
Consul-General.

Frankfort, July 5, 1898.

ELECTRIC WELDING, FORGING AND HEATING.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

One of the most familiar effects of the electric current is the production of heat. The light of the incandescent lamp depends upon the heat for its degree of brilliancy. The arc lamp only reaches a point of sun-like brightness when the heat of the arc intensifies with increased current. The production of heat in an electric circuit can be controlled and reduced so as to be either imperceptible or too great to bear with hand or eye.

In any electric circuit the heat evolved is calculated by the rule—

$$\text{Heat} = C \times C \times R = \text{watts.}$$

Thus the power consumed in producing heat in a circuit having

Resistance = 10 ohms.
Current = 10 amperes.

$$\text{Watts} = 10 \times 10 \times 10 = 1{,}000.$$

An amount of energy exceeding one horse-power would be absorbed under these conditions.

To apply sufficient heat to a piece of metal to melt it requires a volume of current dependent upon its resistance. The greatest heat we have had actual experience with, is that of the electric arc. All the metals, oxides, quartz and granite formations become volatilized in it. Carbon becomes a plastic mass; the diamond, a bit of ash.

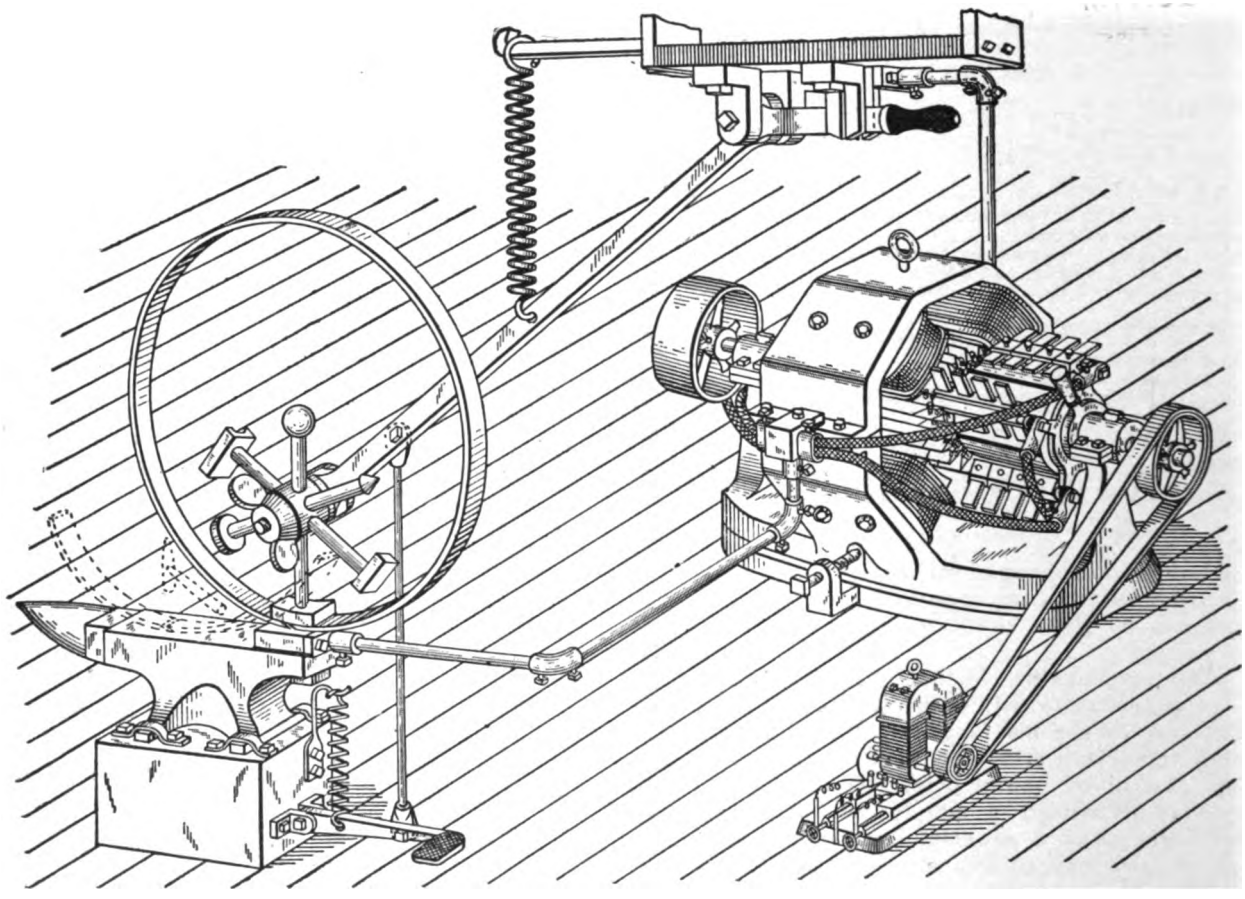
Welding by electricity depends entirely upon the heat produced by the imperfect contact between two pieces of metal. The resistance of the joint causes the heat to localize itself there until the ends in contact become semi-liquefied and ready for permanent junction.

Steel, copper and iron are generally employed for the illustration of this process. The current used is alternating, being transformed down to a few volts when used.

The Thomson Electric Welding Co. have completed machines for practical use which will weld pieces of metal of given cross-section.

One size of welder will successfully join pieces of three square inches in cross-section; the smaller size can weld 1.2 square inches; also welders for the joining of pipe six inches in diameter are manufactured.

The object in view when welding is attempted should be



Electric Forging by the Burton Process.

Sufficient pressure at joint.
Sufficient current.
No oxidation.

The current used for the purpose is generated in an alternator at about 300 volts pressure; it is then transformed down to from 3 to 12 volts, according to the nature of the work to be done.

Many experiments have proven an alternating current the best for welding purposes. The positive pole of an attempted weld with continuous current would be very much hotter than the negative. This would seriously interfere with the weld, while if an alternating current be used the current heats each end equally. If a slight oxidation occurs at the joint, the weld may bind at the edges but be perfectly insecure inside. The instant the heat has arrived at the right point, the two bars of metal must be pressed together as forcibly as possible. This creates a burr on the outside which may be hammered down flush with the rest or removed in the lathe. The

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resulting surface should be smooth, unseamed and continuous when finished, without any signs of the juncture visible.

When steel is welded it sometimes happens that a black, burnt-looking mass forms at the welded point. This is caused by overheating, which drives out the carbon and changes the nature of the metal.

It can be restored by resting in a bed of red charcoal until carbon has been reabsorbed.

If a pail filled with a solution of soda or sal ammoniac and water have a metal plate connected to an insulated wire placed at the bottom, any piece of metal connected to another wire will, when dipped, become rapidly white hot *in the water*; the two wires being connected to a source of current. If one wire is disconnected, the same water serves to cool the metal instead.

Blacksmiths in the neighborhood of Niagara Falls use current from the trolley roads for this purpose, their forge consisting of a pail of water and a pair of insulated tongs.

For purposes of forging, the following figures are given for an 80-lb. bar measuring 1 × 8 × 36 inches.†

Use 220, 250 or 500 volt, direct current.

Set forge level and on a dry floor.

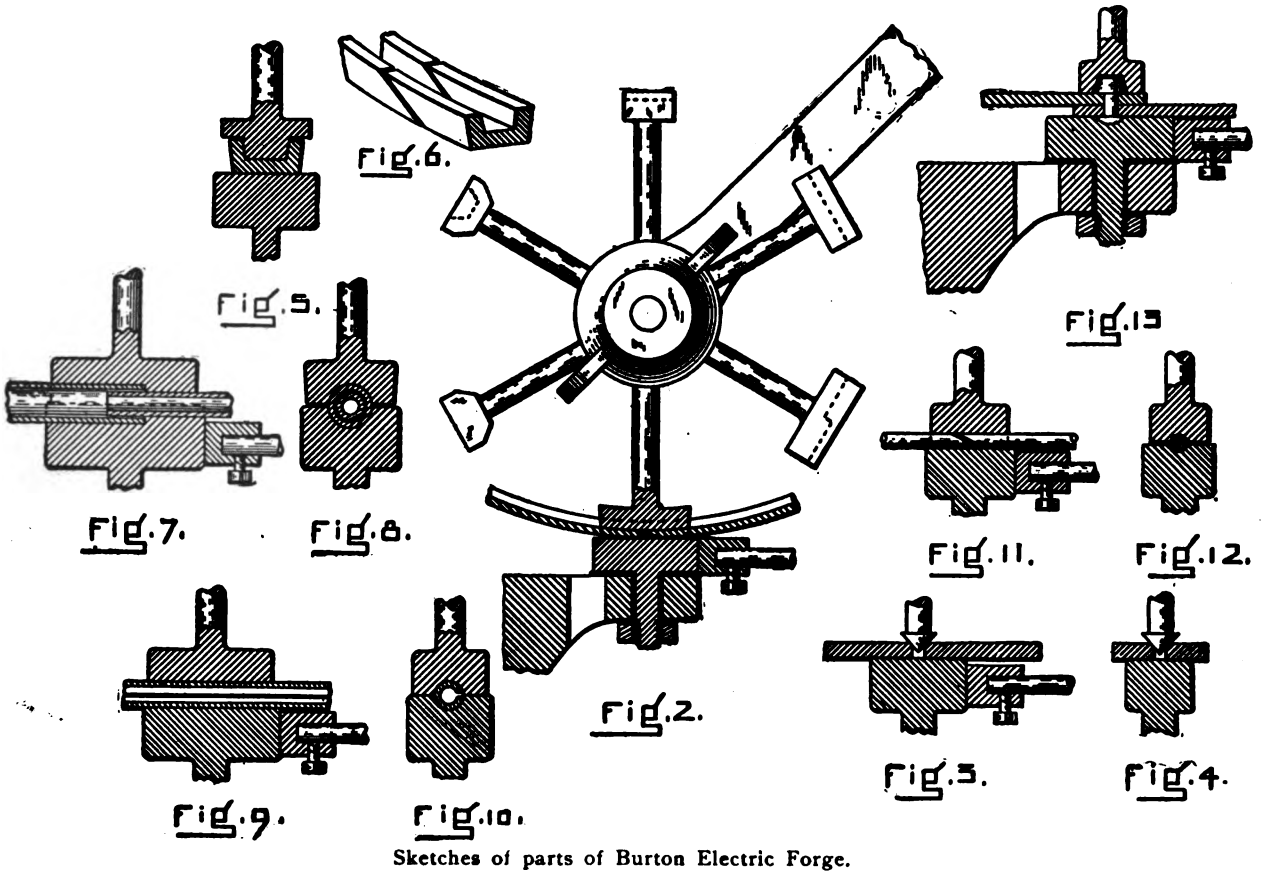
Always connect negative pole to the iron bar on the edge of tank, or there will be no heating effect. Connect positive pole to the wire extending outside the tank.

Fill main tank with water to within 1½ inches from the top. Add 10 lbs. sal-soda and 2 lbs. salt, if 220 or 250-volt current is used, and only 5 lbs. sal-soda and 1 lb. salt, if 500-volt current is used. Whenever the solution becomes too strong and the heat is too rapid, take out two or more pails of water, and add same amount of fresh water.

Use a switch when connecting up between main supply and the tank. Leave switch open when not in constant use.

The forge will heat any metal from a number 40 wire to a bar 1¼ inches diameter, and from ½ to 15 inches long.

Current in amperes varies from 0 to 65 amperes, according to the size of piece heating, the piece itself determining the amount of amperes and acting as a natural



Sketches of parts of Burton Electric Forge.

Cost of heating by coal,	$1.25
" " " " electricity,	0.78
Saving, - -	$0.47

The advantages of an electric forge are therefore not merely those of convenience alone, but to be figured in dollars and cents.

The Burton Electric Smelting Company manufacture machines shown in illustrations. Mr. George D. Burton developed the process by means of which a receptacle or tank of some suitable insulating material holding aqueous solution of sodium carbonite and borax can be used for heating a metal uniformly throughout its mass. The qualities of this electric forge and its remarkable simplicity make it applicable to all kinds of forge work. We append directions for using Burton's electric forge, which will be of great interest to our readers:

Directions for Using Burton's Electric Forge.

regulator. It is best to fuse up the connections with 50 ampere fuses on 500 volts, or heavier on lower potential circuit. When the forge is ready for operation, rest the metal to be heated on the iron bar or circuit negative pole at edge of tank, always resting the metal to be heated first on the bar, then bring it into contact with the solution. If the solution is touched first, the heating arc will be formed on the supporting bar instead of in the solution. To heat a bar in the middle for a given space, rest it on the small bar near the diamond-shaped tile, the portion to be heated resting across the tile; the tile to be filled with the solution and kept overflowing from the spigot during the heating operation.

If the heat is found to be too intense or too rapid, take out a portion of solution and add water; if too mild, add a small quantity of table-salt from ¼ to ½ lb. Always open switch before making any change in the solution; the liquid should stand four hours before using when tank is first filled. By use, the liquid will evaporate slightly; add water when required, so that the tank shall be kept full.

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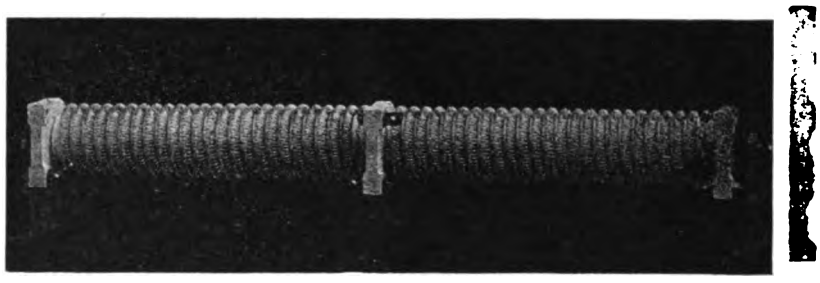
The Electric Forge is protected by U. S. Letters Patent issued to Geo. D. Burton.

For further information, address

Burton Electric Smelting Co.,
144 Lincoln Street, Boston, Mass.

(3) What are the requirements of a successful weld?
(4) How is forging done by electricity?
(5) Is electric forging or welding a commercial success?

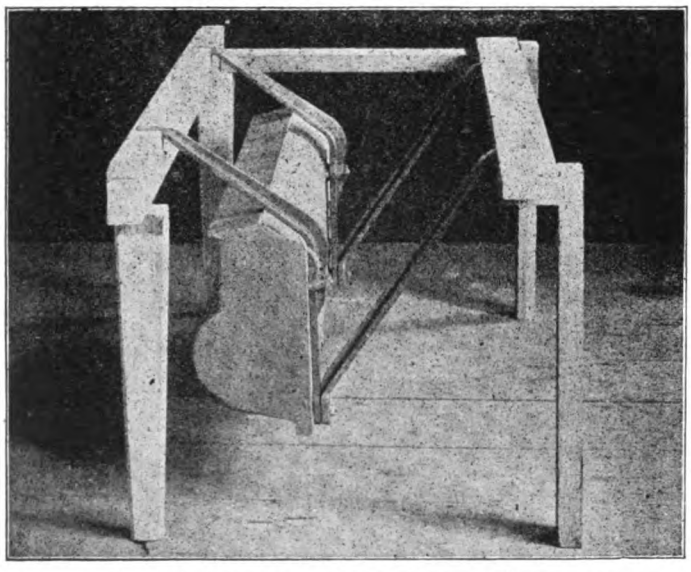
† [Electricity at World's Columbian Exposition.]



Section of Standard Heater, No. 103S, showing two short resistance coils.

Caution.—Always turn off current when not in constant use.

To avoid shocks never put one hand in the solution and the other on the bar or negative pole, nor one hand on the bar or negative pole and the other on the pump.

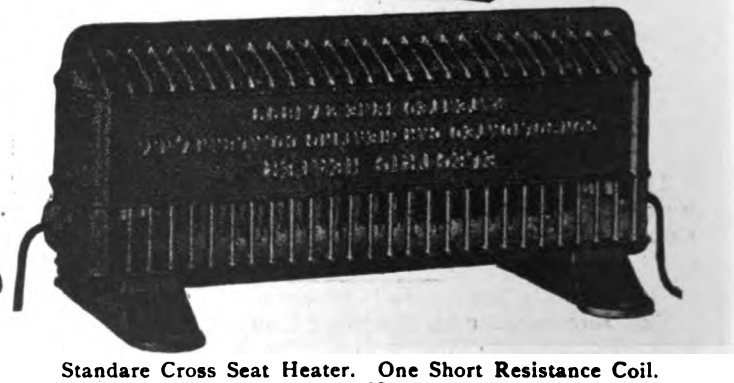


Method of Hanging No. 115K or 115S Heaters.

These requirements must be strictly observed and all danger from shock is avoided.

Heater No. 118 under Seat.

Standard Cross Seat Heater. One Short Resistance Coil.
Heater No. 88C.



Standare Cross Seat Heater. One Short Resistance Coil.
Heater No. 118.

QUESTIONS FOR REVIEW.

(1) How is the amount of heat in an electric circuit calculated?

(2) Upon what conditions does electrical welding depend?

ELECTRIC HEATERS AND TEMPERATURE REGULATING SWITCHES.

The passage of a current through a wire causes a rise in temperature dependent upon the resistance and square of the current. The energy dissipated is measured in

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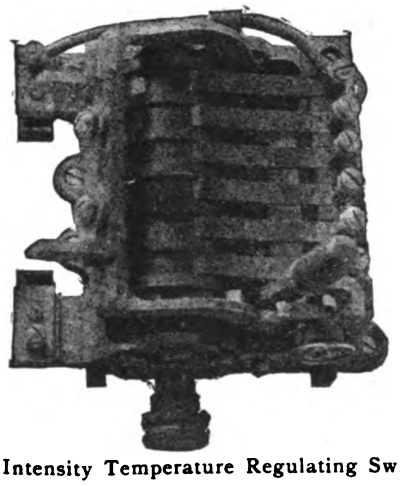
watts, and the temperature is controlled by the radiating surface of the heated body. The heating or warming of apartments, cars, etc., by electricity is accomplished in a very simple manner. A spiral of wire wound spirally around a fire-proof and non-conducting cylinder is enclosed within a metal framework, as illustrated in this article, and through the wire a current is sent and regulated by the turn of a switch. The application of this simple principle is one which possesses the highest efficiency.

The technical student will readily understand why the electric heater is an ideal machine. If 100 watts passes through a heater of this description, heat equivalent to 100 watts will be radiated; in other words, the most economical way to produce heat is by the use of electricity.

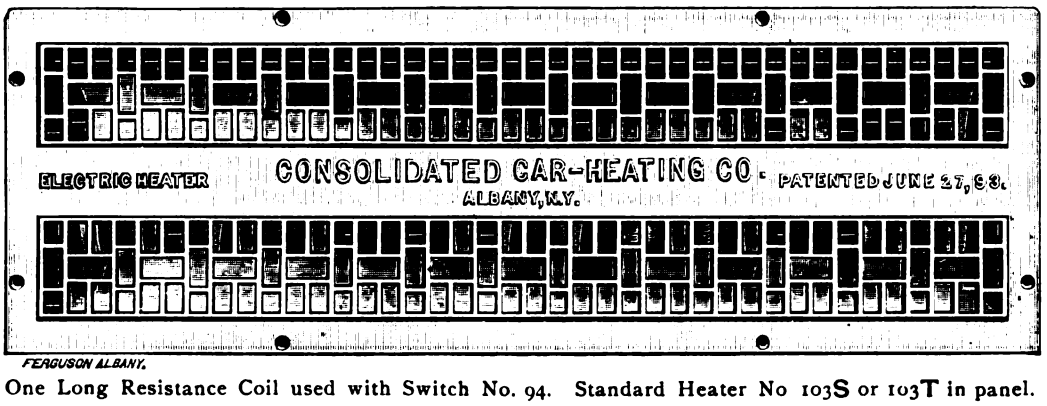
The increasing demand for private installations and electric lights and power throughout all large cities has had its influence in developing a large and growing trade in electric heaters. An appreciation of this fact has brought upon the market electric heaters manufactured by The Consolidated Car Heating Co., of Albany, N. Y., which are in popular use by more than 250 railway corporations in this country.



Fire Intensity Temperature Regulating Swith.

Two standard resistance coils are used by the Consolidated Car Heating Co. in the construction of their electric heaters. They are the long resistance coil, which cannot be used on a 500-volt circuit unless there are two in series, in which case the two coils consume four amperes, or a maximum of 1,000 watts per coil; and the standard short resistance coil, which has a resistance equal to one-half that of the long coil. This coil cannot be used with less than four in series, on a 500-volt circuit, in which case the four coils consume four amperes or a maximum of 500 volts per coil. With the long resistance coil the minimum consumption of current at 500 volts pressure with switch number 94 is 210 watts per coil. With the standard short resistance coil the minimum consumption of current at 500 volts pressure with switch number 127 is 180 watts per coil.

Two Short Resistance Coils Connected in Series. Heater No. 93 or 93S.



One Long Resistance Coil used with Switch No. 94. Standard Heater No 103S or 103T in panel.

One Long Resistance Coil. Heater No. 115K or 115S.

The various styles of heaters shown in this article

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have been almost exclusively used by the largest electric roads in the United States. More that 60,000 coils are in use today, and we find that in our own city the Metropolitan Street Railway Co. make use of them.

The ingenious arrangement by means of which the Consolidated Car Heating Co. can make whatever combinations they desire with their long resistance coil and standard short resistance coil is highly commendable. The amount of heat or current consumption is regulated between its highest and lowest points by means of regulating switches. These in connection with the coils provide a most convenient means of raising or lowering the temperature. A temperature regulating switch is shown among the illustrations. This is used with standard heater equipments. The current consumed on a 500-volt circuit is controlled from 2 to 3, 6, 8 and 12 amperes on switch positions 1 to 5 respectively. With heaters carrying more current control is exercised from 2 to 4, 8, 12 and 16 amperes at the same positions with the same switch.

Switch No. 94 and another not shown, No. 127, are used to control other combinations of heaters besides the standard arrangements given, especially with elevated car equipments. Both can be used to control house heating equipments, but are not recommended on circuits of less than 500 volts pressure. The Consolidated Car Heating Co. place the switches in black japanned iron boxes, 8x8½x3⅞ inches. For concerns or individuals requiring special resistance coils, other designs will be constructed satisfactory to the purchaser.

We conclude by saying that out of 60,000 coils built by this company, and in daily use, not one has failed in five seasons' service. The Consolidated Car Heating Co. may be communicated with at Albany, New York, or at 514 Western Union Building, Chicago, Ill., and Coaticook, P. Q., Can.

THE DEVELOPMENT OF THE CENTRAL STATIONS.

(*Continued from Page 82.*)

The public interest aroused in his work and the controversy as to whether it was possible for him to achieve anything that would be of commercial value is evidenced by the constant reference to the matter in the public press in 1878, 1879, and 1880, resulting in a panic in gas securities in London in 1878 and in New York in 1879. Probably the work of no inventor was more generally discussed on both sides of the Atlantic by laymen and technical authorities alike than was that of Mr. Edison on his electric lighting and power system. All kinds of comparisons were made as to the difference between the cost of gas and the cost of electricity. It was claimed by many that Mr. Edison could not possibly be considered as having succeeded in his work unless he could produce an illuminant that would compete commercially with gas. They lost sight of the fact that the characters of the two illuminants were entirely different, and that there was no more reason for supposing that, if electricity were more expensive than gas, the cost would be a barrier to its use any more than there is reason for supposing that gas should be considered a commercial failure because the poorest classes find it cheaper to use tallow dips. The probable reason for scientists and electricians doubting the possibility of a successful electric-lighting system being produced was that all previous experimenting on incandescent lamps had been, as I have already stated, aiming at producing a lamp of the lowest possible resistance and consequently requiring the greatest possible amount of current, these lamps being run in series, wheras Mr. Edison, at a comparatively early state of his work, realized that the first essential was a lamp of high resistance, and that the only way of approximating an even distribution of pressure was to run these lamps in multiple arc. Hence his application for a patent on a lamp with a high resistance filament, under date of November 4, 1879, and his application on multiple arc distribution in February, 1880. It was then but a short time before he realized that, although experimentally this might give him even pressure, the expense of the copper in his distribution system would be too great, owing to the necessity of increasing the size of his copper as he got farther and farther from the point of generation. The result was that in August, 1880, he applied for his patent on a system of feeders to supply his system of mains at various points throughout the system, the effect being a compact system with current flowing in all directions from the central point of generation through feeders, by means of which even pressure could be maintained throughout a considerable area.

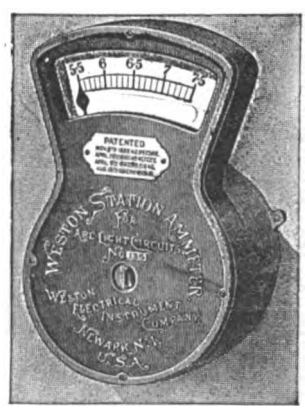
A still further step made by Mr. Edison was the realization that nothing very reliable in the way of a distribution system in large cities could be maintained unless the work was placed underground, and, as a result of his work of a little over two years we find that, in the early winter of 1880, Edison had a central station system experimentally at work at Menlo Park, N. J., having an underground two-wire system, with the homes of himself and his staff electrically illumined by incandescent lamps, motors at work in his laboratory, and, in fact, all of the essential features of what is to-day now so common from the largest cities to the smallest villages throughout the civilized world.

It was but a short time after the starting of the first central station, in New York, that Mr. Edison found himself looking for some more economical methods of distribution; and I well remember his first experiments on the three-wire system, when, at his shop in Goerck street, New York, he placed a third brush on the neutral point of the commutator of a small bi-polar Edison dynamo and demonstrated the practicability of the three-wire system.

At the same time that Edison was working on the three-wire system experimentally in New York, Dr. John Hopkinson was probably figuring out the same thing in England, and Werner von Siemens was engaged in similar work in Germany. The records of the United States, English and German patent offices bear witness to the fact that these three men accomplished about the same results at about the same time, and, as a consequence, between 60 and 70 per cent. of the investment in copper was saved.

(To be continued.)

Hamilton, Ont.—The annual meeting of the shareholders of the Hamilton, Chedoke and Ancaster Electric Railway was held last Saturday. It was stated that $30,000 of the stocks had been disposed of, and that the construction of the road would begin at an early date.



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Miniature Lamps: Candelabra, Decorative, Battery and Series. Catalogue No. 9044.

Edison Decorative and Miniature Lamp Department,
(General Electric Co.)
HARRISON, NEW JERSEY.

WATER WHEELS

TURBINE WHEELS, for Heads of 3 to 220 feet.
CASCADE WHEELS, for Heads of 50 to 2000 feet.
Suited to all Water Power Purposes.
Pamphlet of either Wheel sent free. State your Head.
JAMES LEFFEL & CO. Springfield, Ohio, U.S.A.

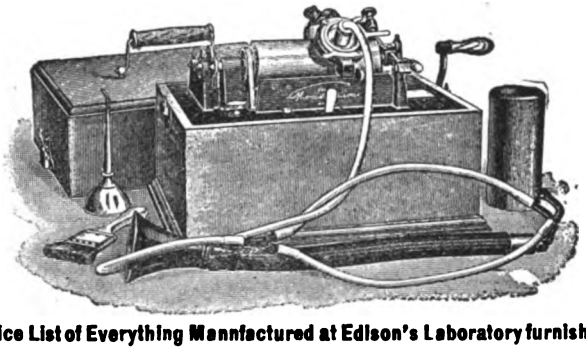
EDISON'S

NEW STANDARD PHONOGRAPH.

EVERY FAMILY SHOULD POSSESS ONE.

Records Reproduces, shaves off cylinders, has sapphire points. Runs 3 records with one winding of spring. Weight, 17 lbs. Complete, as per illustration,

PRICE,
$20.00



EDISON RECORDS are the best, loudest, clearest.

All the latest songs and music, 50 cents each, $5.00 per doz.

Send for Catalog E, complete list of Records.

Catalogue and Price List of Everything Manufactured at Edison's Laboratory furnished on Application.

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Gas Lighting by Electricity.

Static Electric Machines and Burners for the Multiple System.

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TRIO BUILDING.

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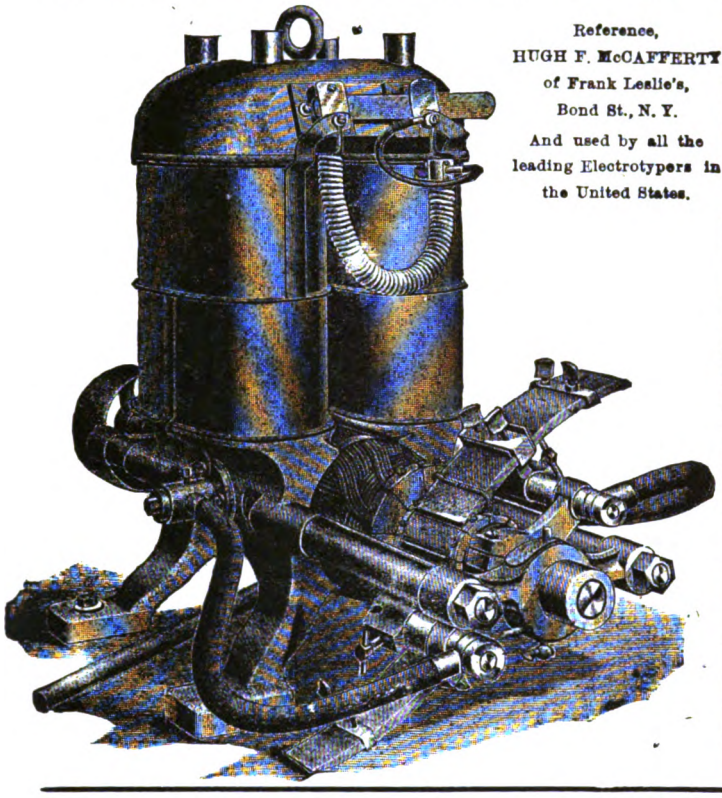
THE WORLD DYNAMO

WILL PRODUCE A SHELL IN 30 MINUTES.

Manufactured by the

ARNOUX & HOCHHAUSEN ELECTRIC CO., 478 & 480 PEARL ST. NEW YORK.



Reference,
HUGH F. McCAFFERTY
of Frank Leslie's,
Bond St., N. Y.
And used by all the leading Electrotypers in the United States.

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SWITCH BOARDS,
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WORKS AND OFFICE:

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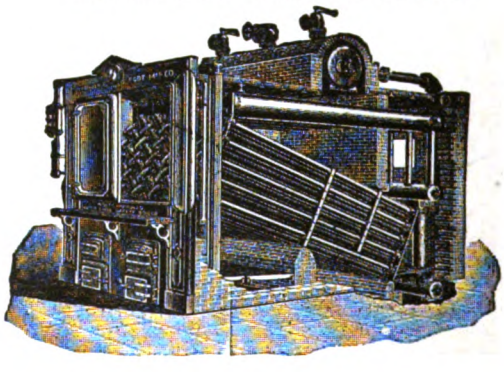
THIS IS THE BOILER

ROOT IMPROVED WATER TUBE BOILER.



Selected by leading Electric Light Plants and Street Railway Companies throughout the United States. The following are the acknowledged requirements in water-tube boilers: *Straight tubes which can be thoroughly inspected and cleaned inside and outside; perfect suspension, allowing free movement of whole boiler expanding and contracting; perfect flexibility for the difference in expansion between upper and lower tubes; interchangeable parts, built to fixed standards; facilities for making quick and easy repairs which can be done by your own engineer or machinist; a cover joint which can easily be made tight, and frequently broken and replaced without injury; provision made to introduce the feed water where it will not chill and moisten the steam; provision made to carry feed water impurities direct to the mud drum and not past the ends of the tubes; provision made to supply the lower tubes with a bountiful supply of cool water; the use of the best materials and fittings the market can afford; the best possible workmanship; a large disengaging surface for the steam to escape from the water; small cast iron pressure parts; ample heating surface to prevent injury to parts should boiler be forced above its rating.*

Examine these Points in the Improved Root Water-Tube Boiler.
Send for our Illustrated Catalogue.

ABENDROTH & ROOT MFG. CO., 28 CLIFF ST., NEW YORK CITY.

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The Electrical Age.

VOL. XXII—No. 8 NEW YORK, AUGUST 20, 1898 WHOLE No. 588

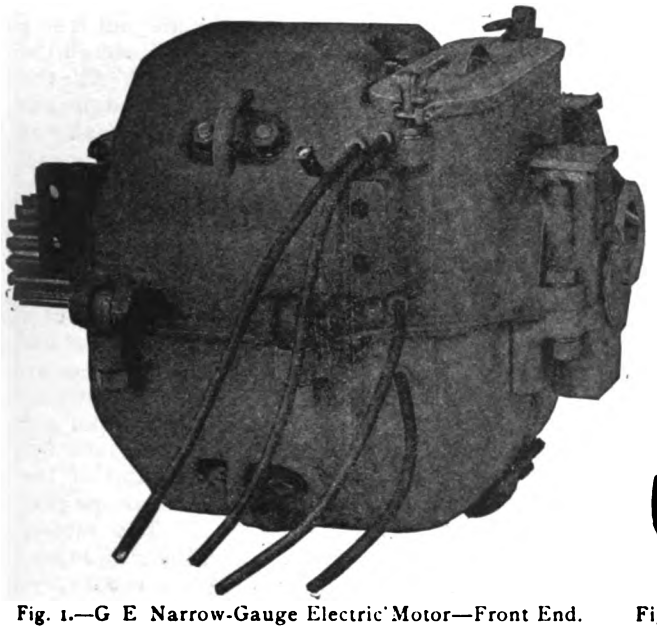

Fig. 1.—G E Narrow-Gauge Electric Motor—Front End.

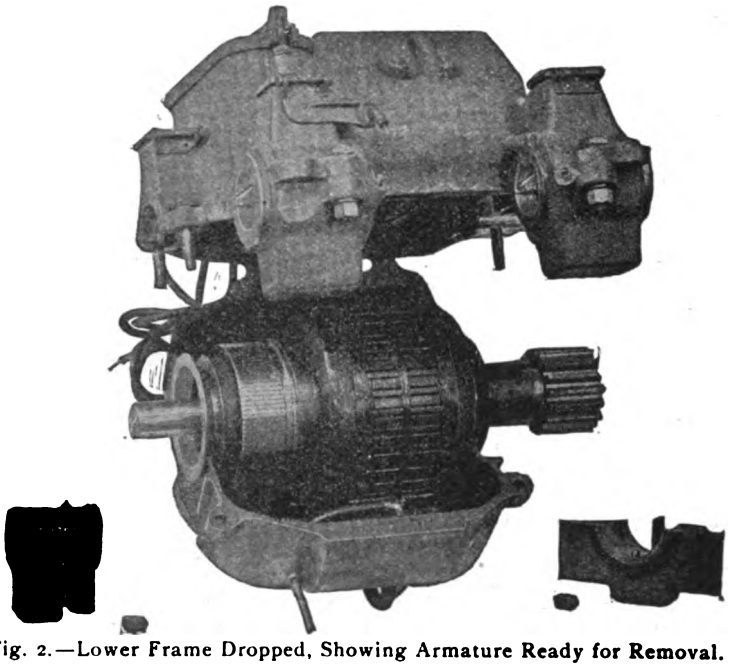

Fig. 2.—Lower Frame Dropped, Showing Armature Ready for Removal.

NARROW GAUGE ELECTRIC MOTORS.

The operation of a narrow gauge road demands a railway motor occupying a more restricted space than the motor built for standard gauge roads, while giving the same power. The General Electric Company has manufactured narrow gauge motors for some time past, and many are in actual service, giving the same high degree of satisfaction as the other types of the G. E. standard gauge motors. One type of narrow gauge motor now built is the G. E. 58, which resembles in outer appearance the standard gauge motor, and has an output of 37 H. P. based on the standard General Electric rating, i. e., a maximum rise of 75° centigrade in the temperature of the windings after a run of one hour at rated load, the temperature of the surrounding air not exceeding 25° C. This motor is built for comparatively heavy service, in which the G. E. 52 motor would be too light, and is especially desirable in cases of combined city and interurban service with moderately high speeds and heavy traffic. While designed for a minimum gauge of one metre (39 1-4 inches), the G. E. 58 may be used with wider gauge roads.

Magnet Frame.

The magnet frame is made of soft steel of high magnetic permeability, cast in two bowl-shaped halves. The frame is divided in a horizontal plane, and the two parts, when bolted together, completely enclose and protect the armature, commutator, brush-holders and field coils. Extension pieces are cast on the top at each end and extend over and partly enclose the car axle. To the under side of these extension pieces are bolted the axle-bearing caps, bored out to support and enclose the axle linings. The armature supports are made by bolting the bearing caps to the under side of the top frame at each end and boring them to receive the linings. The bottom frame is secured to the top frame by bolts, so hinged that when the rear bolts are removed the lower frame will swing down, exposing the armature and field coils for inspection and cleaning. In this position the bottom of field coils may be easily taken out, while by removing the armature caps and the bottom half of the gear case, the armature and top field coils may be easily removed.

A large opening is provided in the top frame just over the commutator, through which the commutator, brush-holders and brushes can be inspected and worn-out brushes replaced. Through the same opening it is possible to remove the brush-holder yoke and brush-holder bodies. A malleable iron cover is securely held in place over this opening by an adjustable cam-locking device and is easily and quickly removed. A hand hole fitted with a gasket and cover plate is provided in the bottom frame directly under the commutator, permitting easy access to the bottom of the motor for inspection and removal of foreign substances.

Bearings.

Appreciating that the renewal of linings is frequently the principal item of maintenance cost of a motor, particularly when designed within the limitations of narrow gauge, much attention has been given to the design of the linings and the bearings. The armature bearing linings are made of machined cast iron with 3-16″ Babbitt metal swaged hard and bored to the proper size to fit the shaft. The bearing of the commutator end is 2 5-8x6 5-16″, and on the pinion end 3x7 7-8″. The supports for the linings are constructed on the outboard plan, which renders the bearings easily accessible and prevents oil or grease from working into the motor frame. The support for the upper half of the armature shaft lining is cast as a part of the upper half of the frame and is provided with a large cored recess between the inner end of the lining and motor frame. This space is utilized for a thrust collar, so designed that its outer edge acts as an oil guard and turns in the recess between the motor frame and the bearings. The support for the lower half of the lining is a cap bolted to the upper frame, in such a way as not to enclose the lower half of the oil guard, thus allowing free egress for the lubricant after it has passed through the bearing. The axle bearing linings are similar to the armature bearing linings and are 8″ in length and of the re-

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quired diameter to fit the car axle. The upper supports for these linings are cast with the upper frame; the lower supports are caps bolted to the upper support.

All bearings on the motor are provided with grease boxes and oil cellars of sufficient capacity for thorough lubrication. The grease boxes are cast with the upper frame and are covered with flanged lids held down by springs to exclude the dust and dirt. Oil cellars of ample capacity are provided in the bearing caps. The oil is fed by felt wicks or wipers, which come in contact with the shaft through holes cut in the linings.

Field Coils.

The motor has four field coils, two in each frame, placed at an angle of 45° from the split, and held in place by pressed steel flanges, or spool holders, clamped by projections on the laminated pole pieces. The pole pieces are held in place by through bolts with nuts on the outside of the frame, the coils being placed in position when the pole pieces are bolted to the frame. The field coils are wound with round wire insulated with asbestos, and are substantially insulated over all with wrappings of varnished cloth and tape. The insulation between field coils and motor frame is tested by 5,000 volts alternating—sufficient to thoroughly prove the quality of the insulation. The field-coils leads are brought out through the frame in a convenient manner for connecting to the car wiring, and it is not necessary to disconnect any leads inside of the motor frame when dropping the lower half for cleaning.

Armature.

The armature is of the well-known iron-clad type and is 14 1-2″ in diameter with a spread of 6 1-2″. The core is built up of well annealed laminations and is assemblod directly on the shaft. There are 33 slots, and each slot contains three coils, collected together and insulated so as to form one triple coil. Hence there are 33 triple coils connected with 88 commutator bars. A small number of coils is of especial advantage when an armature has to be repaired, and the method of forming the coils into groups of three admits of substantial insulation of high quality. The insulation of the coils consists of specially prepared tape and cloth, which has high insulating qualities and is impervious to moisture. When the coils are in place on the armature core they will withstand without injury a high potential test of 2,500 volts between the windings and the core.

The terminals of each coil are brought directly into the commutator segments and soldered so as to properly connect the armature coils, and at the same time form the connections between the armature windings and the commutator. The end windings are effectually protected from mechanical injury and carbon dust by the metal core heads and by a canvas dressing. The coils are held in place in the slots and on the ends by tinned steel wire bands, held together by clips and securely soldered.

Commutator and Brush-Holders.

The commutator is 10″ in diameter. Its segments are 4 3-8″ long, with a wearing depth of 1″, and are insulated from the shell by cone-clamping insulations of the best quality of pressed mica. The segments are of the highest grade drawn copper of uniform hardness, and are slotted at the back for the armature leads. The mica between the segments is of a somewhat softer quality than that used in the clamping insulations, to insure an even wear with the copper segments. The completed commutator is tested by 5,000 volts between segments and shell and 500 volts between adjacent segments. Particular attention has been given to the matter of commutation, and under normal conditions the commutator will run with practically no sparking.

The brush-holders of cast brass are constructed to receive two carbon brushes per holder. The brushes are 1 3-8x2 1-4x1-2″. They slide in finished ways and are held in place against the commutator by independent pressure fingers, which give a uniform pressure to the brushes throughout their entire working range. The brush-holders are clamped to a hard wood yoke, carefully treated with a moisture-proof insulating compound. The brush-holder yoke is bolted to the top magnet frame and is so arranged that it may be removed through the opening in the frame over the commutator. All the leads from the motor to the car body are brought out through the rubber bushed holes in the magnet frame at the front of the motor, thus facilitating wiring of the car.

Suspension.

G. E. 58 motors are adapted to nose, yoke or side-bar suspension. The yoke suspension is especially recommended, as the weight of the motor is carried on springs placed upon the side of the truck frame. Lugs are cast on the upper magnet frame, to which the suspension bar is bolted; the lower half may, therefore, be swung down into the pit without disturbing the upper half, which remains suspended from the axle and yoke. When the motor is mounted on 33-inch wheels the clearance between the bottom of the motor frame and the top of the rails is 4 1-4″; the clearance between the bottom of the gear case and the top of the track is 4 1-4″. The motor, without gear or gear case, weighs 1,865 lbs.; and complete, with both gear and gear case, weighs 2,150 lbs.

OHIO ELECTRIC LIGHT ASSOCIATION.

The fourth annual meeting of the Ohio Electric Light Association was held at the West House, Sandusky, August 18th and 19th. The convention assembled at 10:30 o'clock on the morning of August 18th, at the West House, Columbus avenue and Water street.

Mr. E. C. Schmidt, vice-president of the association and superintendent of the Sandusky Lighting Company, had arranged a programme of amusements for the ladies during the sessions of the convention, including yachting and a trolley ride to the Ohio Sailors and Soldiers' Home and special trips to Cedar Point, on Thursday or Friday evening, where there were special attractions. On Saturday, August 20th, by arrangement of the Sandusky Lighting Company with the steamer Arrow, the members of the association and their friends will be taken for a trip to the islands. The steamer will leave Sandusky at 9:40, arriving at Put-in-Bay at 11:30, where members can get dinner at the Hotel Victory. On the return trip the members can leave Put-in-Bay either at 3 p. m or 6:30 p. m., arriving at 4:45 and 8:15 respectively. The return trip in the evening will be by the south channel, passing the Hotel Victory, Catawba Island, Lakeside and Marblehead.

Following is the list of papers read and discussed during the convention:

"Positive and Negative Economies in Small Central Stations," by E. P. Roberts, M. E., of Cleveland.

"Some Suggestions Relative to Determining the Cost of Electrical Supply," by M. E. Turner, of Cleveland.

"The Meter's Relation to the Dividend," by Caryl D. Haskins, of Boston.

"Comparative Commercial Qualities of Old and Modern Transformers as Applied to an Exchange," by J. H. Perkins, of St. Louis.

"Long-Distance Transmission of Power," by E. J. Berg, of Schenectady.

The following topics will also be discussed:

"What are the advantages and disadvantages of enclosed arc lamps for outside lighting?"

"Can the candle power of an arc lamp be accurately determined by the use of a portable photometer?"

"In what way can competition of the gasolene incandescent burner be most successfully met?"

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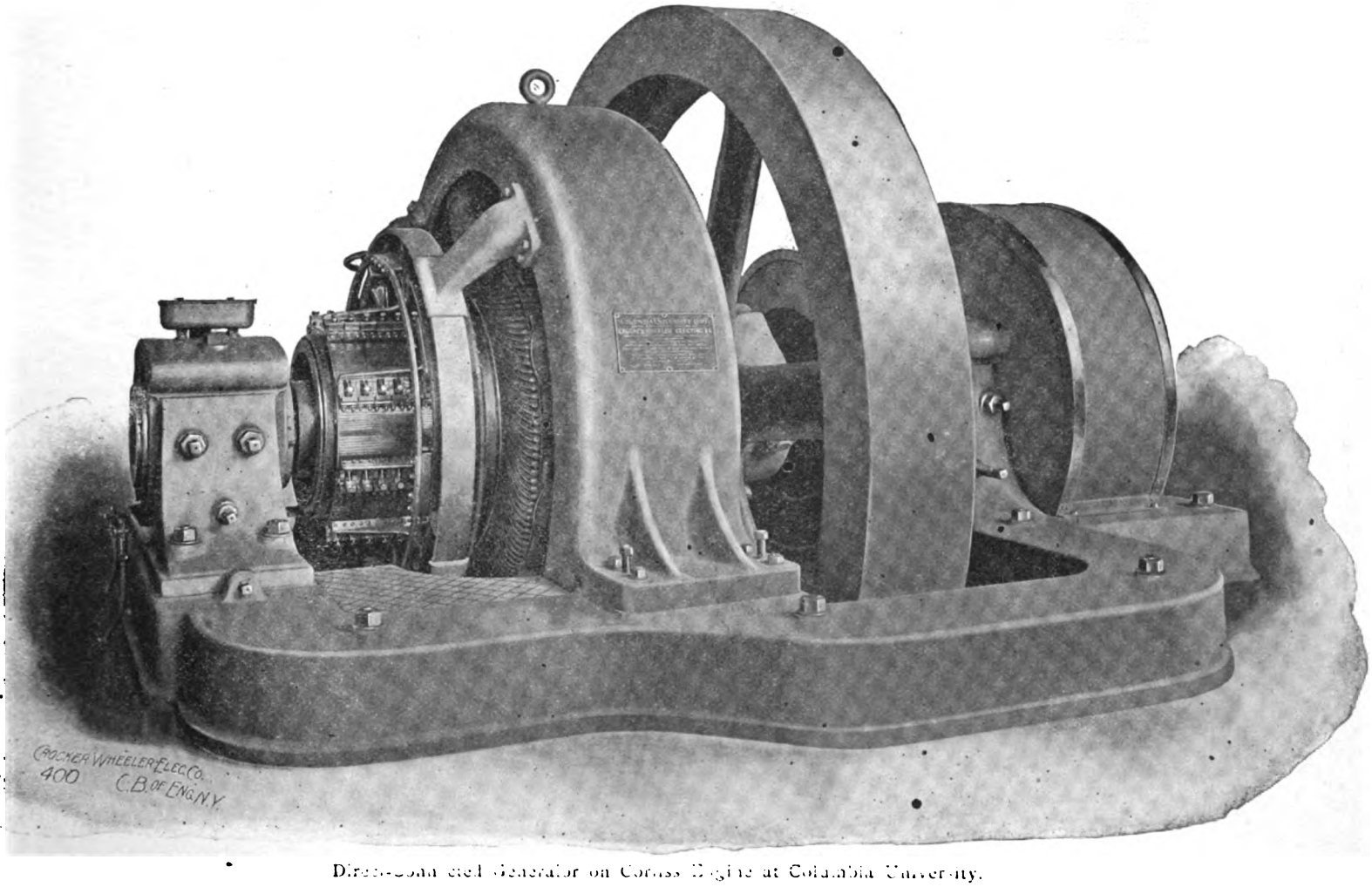
"Is it advisable for a plant to change from 15,000 volts alternating single-phase to 7,200 two-phase if no question of motor business is concerned?"

"What are the types and makes of engines in use in the smaller plants of the association; the time of their installation and their condition at the prosent time?"

The officers of the association are: President, H. K. Wood, Piqua; Vice-President, Emil C. Schmidt, Sandusky; Secretary and Treasurer, Samuel Scovil, Cleveland; Executive Committee, John I. Beggs, Cincinnati; B. P. Holmes, Youngstown; B. P. Foster, Norwalk; George Matt, Lancaster; E. H. McKnight, Middletown; Advisory Committee, J. Gwynn, Steubenville; A. W. Field, Columbus; D. S. Gaskill, Greenville; Finance Committee, John H. Miller, Springfield; J. I. Cooke, Ironton; Edward F. Gwynn, Delaware.

THE WARD ELECTRIC SUPPLY & CONSTRUCTION COMPANY,

Contractors and dealers in "Ward" and "Knight" lamps, imported and domestic carbons and supplies, Eugene H. Levy, Jr., president and treasurer; Chas. O'Keeffe, vice-president, and Deronda Levy, secretary and general manager, have moved to their new and handsome quarters, 194 Broadway. They are Greater New York agents for the Washington Carbon Co. They carry a big stock of plain and ornamental open and enclosed arc lamps, and give immediate attention to correspondence and telephone orders. They have every facility for carrying out contracts for complete electric light and power plants, wiring, etc. Portable and ceiling fans for all circuits. Power motors, all sizes in stock and installed on short notice. They keep in stock search lights of any candle power. Office, 194 Broadway, New York; storeroom, 14 Cortlandt street. Telephone, 4178 Cortlandt.



Direct-connected Generator on Corliss Engine at Columbia University.

IMPORTANT TELEPHONE NOTICE.

The Montclair and Bloomfield Telephone Co., Independent Telephone Co, office, 462 Bloomfield avenue, Montclair, N. J., James Henderson, president; I. Seymour Crane, vice-president; Alfred S. Badgley, counsel; Geo B. Harrison, secretary; Morgan W. Ayres, treasurer, and C. H. Carter, manager.

This company are now operating 150 telephones in Montclair under most successful auspices. The capitalists of this company have secured a charter for Bloomfield and Glen Ridge, N. J., and also New Rochelle, N. Y.

They are in the market for 500 sets of instruments, line material, switchboards, underground cables, etc Mr. C. H. Carter, manager of the Montclair Co., is one of the most successful telephone men in this country.

Burk's Falls, Ont.—The Magnetawan Tanning and Electric Co. purpose extending their building and plant.

ISOLATED ELECTRIC LIGHT PLANTS.

Part of the domestic equipment of some homes, particularly in the country and near the suburban portion of the city, is a gas plant. The modern residence is dependent to a large extent upon outside assistance for the continuation of the comforts within. The country resident, however, with any pretensions toward a life of luxury, cannot rely one iota upon gas pipes, water pipes, steam pipes, etc.

A home in the country is self-contained and all conveniences are found on the premises. The successful farmer leads the most comfortable life of any of this vast country's inhabitants, more perhaps on account of his independence than because of his isolation. Many farmers of the superior class, alive to the innovations of

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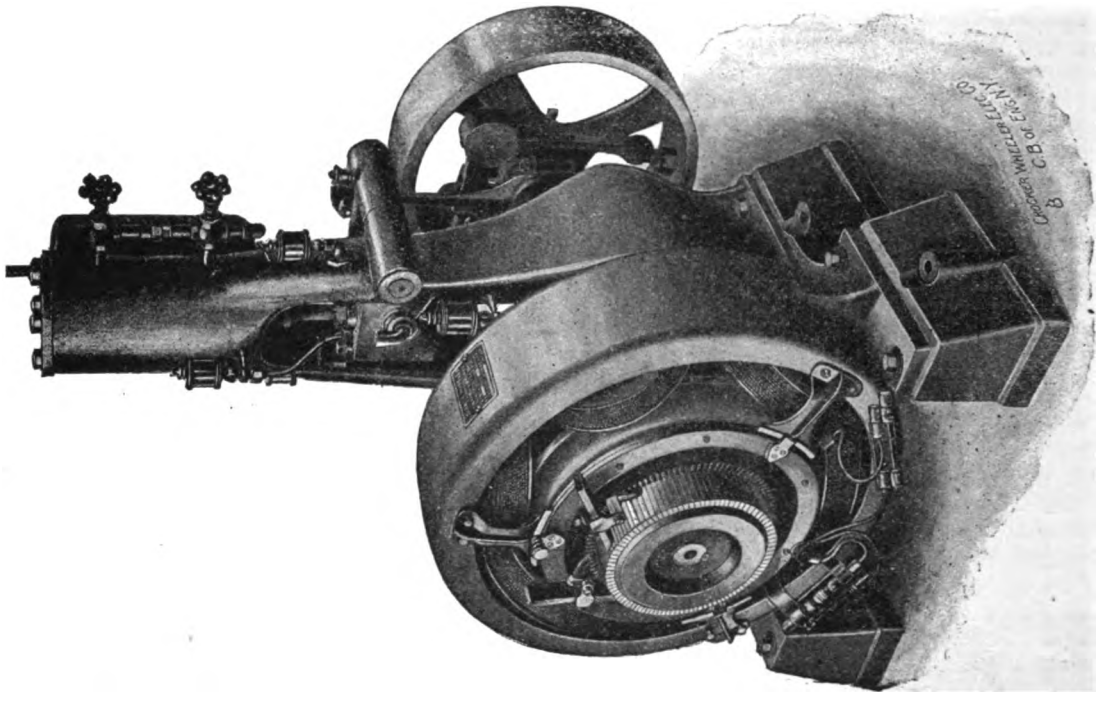
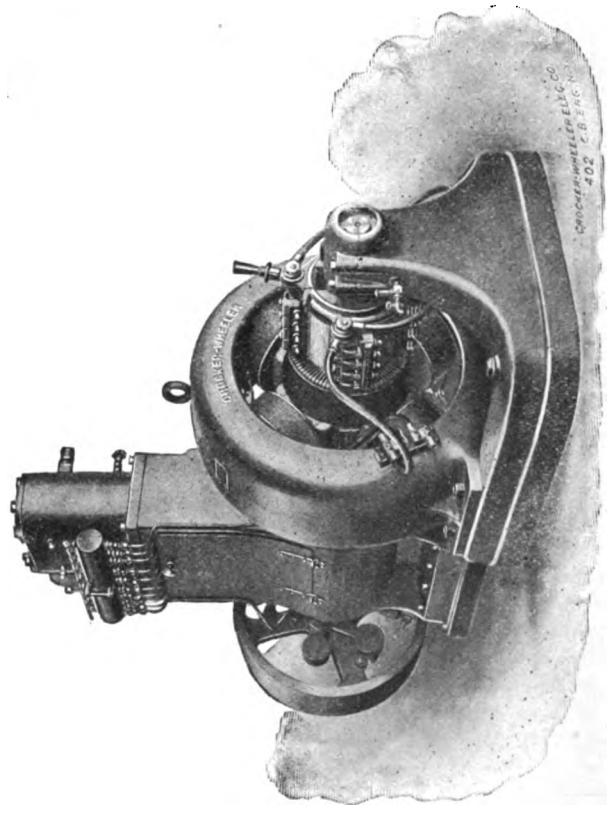
this century, have interested themselves in each one as they appeared.

Not the least interesting to proprietors of apartment houses, private homes in the suburbs or the country, is the electric light plant, some illustrations of which are given in this article. An engine connected to a dynamo, as shown, has in many respects proved to be a form of happy investment, cherished by many enterprising tax-payers. An electric light plant of moderate size, ranging say from fifty to a hundred lights, will prove to be so satisfactory, if properly attended to, that the possessor of it will never cease congratulating himself upon his acquisition. The cost of gas even at $1.00 per thousand is expensive compared with the small well-tended electric light plant.

The use of oil is dangerous though cheap, and the care and attention a gas plant requires is exhausting work. In establishments where hired help is a regular thing, the additional cost of a young engineer is trifling in comparison with the money saved by the use of electric light in this manner.



Plant Installed in a U. S. Torpedo Boat.



Installed in Gould's Yacht, Niagara—24 K. W. Dynamo Coupled to 6x5 Sturtevant Engine, Crocker-Wheeler Electric Company.

To show on a large scale what an isolated plant means reference is made to Columbia University when at its old site. A thesis on the relative cost of lighting by gas and electricity in that establishment shows that ten thousand dollars a year were saved by the use of electricity instead of gas, the exhaust steam from the boilers heating the rooms. This is true, of course, of any small electric light plant as well, in the country and in the city. It is not likely, however, that the practice of running small elec-

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tric light plants in city homes would pay because of certain municipal restrictions, and possibly the cost of an able engineer. But in thousands of cases a plant could be installed and run for little more than the cost of coal. Many farmers and southern planters have water-power on their land. They, of course, could dispense with the necessity for a steam engine and do their electric lighting at a nominal figure, but even then the cost of a dam, turbine, etc., would be so much greater than that of steam engine, boiler and coal per annum, that the plan might not be satisfactory.

A great field exists for the introduction of small steam electric light plants in the country where a few additional comforts of this description would never cease to be appreciated. The moderate cost and limited expense of operation are certainly strong inducements in their favor.

AMERICAN STREET-RAILWAY ASSOCIATION CONVENTION IN BOSTON.

One of the largest and best attended meetings of the American-Street Railway Association will be held in Boston, September 6th to 9th. Hotel accommodations for visitors and space for exhibitors will be provided for, although the Hotel Brunswick, having already booked a large number of reservations for rooms at the convention, has its accommodations almost exhausted. Other hotels in near reach of this last-named are hotels Vendome, Commonwealth Avenue; Copley Square and the Thorndyke Providence Station. Among other hotels may be found the Asams House, Young's Hotel and the Parker House, near the centres of commercial activity and from ten to twenty minutes' ride from the convention hall. The La Touraine, one of the most magnificently equipped hotels in this country, located at the corner of Boylston and Tremont streets.

At the Brunswick five manufacturers only have been able to secure headquarters on the ground floor, namely, the General Electric Company, which has the main reception room; the J. G. Brill Company, directly opposite; the Peckham Motor Truck & Wheel Company, the Pennsylvania Steel Company and the Bethlehem Iron Works. On the second floor, headquarters have been secured by the Westinghouse Electric Company and the Christensen Engineering Company.

The convention space for exhibition purposes is practically unlimited in amount, and manufacturers may feel confident of securing all of which they may apply for. Applications should be sent to Charles S. Clark, chairman committee on exhibits, Mason Building, Boston, Mass.

The street-railway managers around Boston are taking most lively interest in the coming Convention. A strong general committee has been appointed to take care of the Convention, with General William A. Bancroft, vice-president of the Boston Elevated Railway Company, as its chairman, and with a large number of sub-committees, whose chairmen form members of the general committee. The plans for entertainment of the visitors have already been partially formulated, and include a harbor excursion of the most interesting character.

One of the points of interest to be noted in Boston will be the new subway, which we expect to see entirely completed by the time the American Street-Railway Association meets. Besides this there are many specimens of engineering in and around the vicinity of Boston which will keep delegates busy examining. On the whole this convention promises to be one that will mark an epoch in the history of the association, and we hope that all our friends finding it possible will attend the above gathering.

Brantford, Ont.—A company has been formed here for the construction of an electric railway between Waterford and Port Dover.

THE DIESEL CALORIC MOTOR AT THE MUNICH EXPOSITION.

In a report describing briefly the new caloric motor invented by M. Rudolf Diesel,* it was stated that at the machinery exposition to be held at Munich this summer a collective exhibit would be made by the several firms and companies in Germany which have begun the manufacture of Diesel motors of different types for practical use.

The exposition was opened with great éclat early in the present month and will continue until October. The display of Diesel motors occupies a special building, and, in view of the originality and vast economic importance of the new engine, is recognized as the most interesting feature of the exhibition. The interest manifested in this invention by American engineers and machinists has been so general and insistent that a brief account of what can be seen at Munich during the coming three months may be of timely import, although it is generally known that all patented rights for the construction and use of the Diesel motor in the United States have been acquired by an American company whose main office is at No. 11 Broadway, New York.

The collective exhibit at Munich is made by the Augsburg Machine Company, where the invention of Mr. Diesel was first built and tested in practical form. Messrs. Fred Krupp, in Essen, the Machinery Construction Company, of Nuremberg, and the well-known Otto Gas Motor Manufacturing Company, of Deutze-Cologne—four of the most important and powerful manufacturing firms in Germany, whose names form a sufficient guaranty of the industrial value of the new engine. The Diesel motors on exhibition are five in number, and are described in the official catalogue as follows:

(1) By the Augsburg Machinery Company: Single cylinder, 30-horse power motor, for petroleum fuel; drives a rotary pump that lifts 1,600 litres (398 gallons) of water per minute to a height of 60 metres (196.7 feet.)

(2 By Fred Krupp, of Essen: Single-cylinder, 33-horse power engine, which drives a high-pressure, centrifugal pump that draws up from the River Iser a stream of water that is projected through a two-inch nozzle at 45° elevation to a distance of 230 feet into the river.

(3) By the Machinery Construction Company, of Nuremberg: A single-cylinder, 20-horse power motor, which, at a speed of 180 revolutions per minute, is used for purposes of test and demonstration.

(4) By the same company as above: One double-cylindered, 40-horse power motor, coupled directly to a Shückert dynamo, and at 180 revolutions per minute generates current for lighting the pavilion and driving a fast rotary printing press and several machine tools which are installed in the same building.

(5) By the Otto Gas Motor Manufacturing Company, of Deutz-Cologne: One single-cylinder of 20-horse power, which propels a Linde condensing machine for the production of liquefied air.

Besides the four firms above named and represented at the Munich Exposition, three others—viz., the H. Paucksch Co., at Landsberg-on-the-Warthe; L. A. Rudinger, of Augsberg, and the Diesel Motor Fabrik, a special establishment organized at Augsburg for the purpose—are all now interested and engaged in the manufacture of Diesel motors for practical use. The invention, which was first publicly described at the meeting of the German Engineers' Association hardly a year ago, has thus already entered upon its career of economic usefulness.

The Munich Exposition of 1888 revealed as its dominant note the previously unknown preeminence of Germany in the development and utilization of the gas engine as a source of motive power, and it will be the principal function of the exhibition of 1898 to show in how far the Diesel motor surpasses—in respect to economy of space

* See Consular Reports, No. 208 [January, 1898, p. 21.]

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and fuel, cleanliness and practical efficiency for a wide range of purposes—all other motors, whether propelled by steam or which dispense with the evaporation of water and burn the fuel inside the cylinder.

Frank Mason,
Consul-General.

Frankfort, June 25, 1898.

CANADIAN LETTER.

Electric Railways.

Lanark, Ont.—It is claimed that the necessary capital has been secured for the construction of the proposed electric railway between Lanark and Perth.

Nelson, B. C.—S. C. Drummond, representing The British Electric Traction Co. of London, Eng., has applied to the City Council for a charter for an electric railroad. The Council has signified its willingness to grant the application on suitable terms.

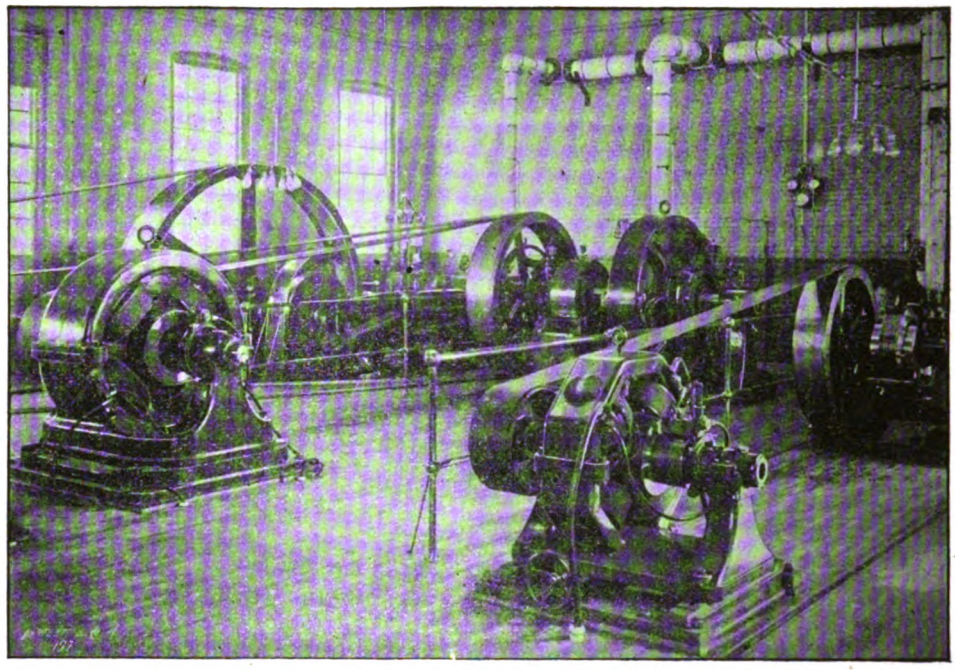
THE TRANSMISSION OF POWER.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

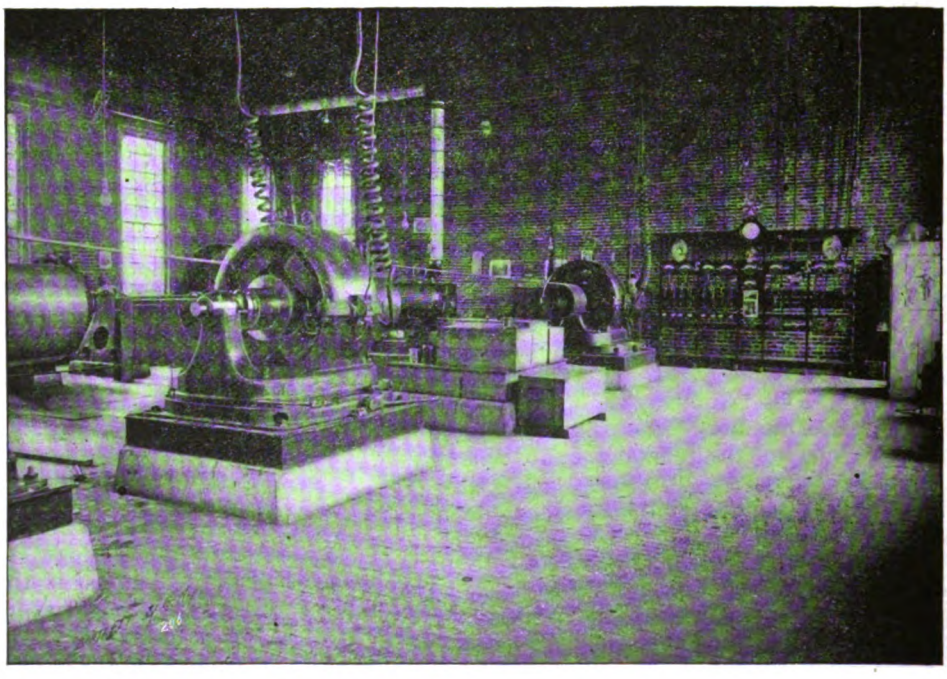
BY NEWTON HARRISON, E. E.

Power is transmitted by means of

Steam,
Wire Rope,
Electricity,
Compressed Air,



Interior of Power House, Crocker-Wheeler Works, Ampere, N. J.



Power Plant, Granite City Steel Company, Granite City, Ill.—Three 100-Kilowatt 230-Volt Dynamos, Furnishing Current for Arc Lamps, 220-Volt 16-Candle-Power Lamps and Motors from the Same Machines.

Hydraulic Pressure.

The evident use of each is only to be determined by the existing conditions. At present but two have received such consideration as is required to lift them into prominence.

They are wire rope and electricity. In our busy towns

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The Electrical Age.

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INJURY TO ELECTRICAL INVENTORS.

The recurrence of great frauds related in some way to the electrical science has led many investors to shun electricians as they would his satanic majesty. This is mainly on account of schemes developed by adventurers on frequent occasions and supported by the gullible element. The mystery surrounding electrical inventions is regarded by the long-suffering public even at this late hour as a sign of their value, a proof of their evident originality. The Keeley motor is an example of this in the field of applied mechanics, and in all respects the recent efforts of the Rev. Mr. Jernegan is a fair illustration of what people believe in relation to electrical discoveries.

Preposterous as the idea is of actually extracting gold from sea-water we are certain that the backing of scientific fact upon which this process was supposed to rest was not doubted for an instant by the laymen. Science wields the wand of control over Nature to an extraordinary degree and brings to light wonders that the uniniated only regard as facts after repeated proofs of their existence; yet such a scheme as the extraction of gold from the sea was considered possible without other tokens than those presented by the ringleaders of the Electrolytic Marine Salts Company.

The serious effects of this upon investors or those claiming a less dignified title, aside from the fact that they are solely to blame, is to make them regard everything related or associated with electricity as a fraud. Not only is this detrimental to the profession by crushing all efforts on the part of inventors of electrical devices to place their patents, but it retards the process of practical commercial development in several ways.

Those already interested in electrical enterprises may fall away in fear, and others preparing to invest in what was regarded as legitimate will feel by this disclosure that they have been saved from a sad fate and retire with a shrewd wink at their own perspicuity.

The throttling of legitimate enterprises is one of the worst accidents that can happen to a growing science. Although requiring no further recommendation than the successes already achieved, the application of electricity to a new purpose is now apt to awaken suspicion in the minds of those always anxious to be on the safe side and possessing a painful recollection of events connected in the past with shady propositions. This class of men are of course as great an obstruction to progress as the milder form of frauds. What would certainly prove to be an excellent antidote more effective than anything that could be otherwise suggested would be the possession of information by business men and the general public of the limitations of applied electricity.

The time has arrived in which no man can consider himself well informed who does not possess some knowledge of the fundamental principles of applied sciences. Knowledge is undoubtedly power in virtue of such an education and may be the saviour of many a bank account from complete destruction.

The idea that this is the age of specialists is true in the sense that livelihoods are best earned by those imbued with resolution enough to stick to one business or profession. It is not necessary to conclude from this that a familiarity with simple facts in connection with any other subject is a departure from the beaten paths and therefore inimical to success. Not in the least; such knowledge is helpful. It protects the specialist from imposition. It is a shield from attacks that threaten his present prosperity and future happiness.

Business men are as much exposed to the machinations of schemers as our New England lambs. Case upon case could be cited showing the credulity of experienced New York business men, but none in which professional men have been fooled in their own science. An elementary training in a few of the important principles and applications of electricity by the general public would undoubtedly have saved thousands of dollars from the clutches of the Rev. Mr. Jernegan.

The daily newspapers and periodicals have for many years taken an extraordinary interest in all electrical discoveries and inventions. The knowledge the people possess of the electrical science is obtained by them mainly from these sources. Of course the facts are superficially stated and possess little value as a source of instruction, but they at least make the people acquainted with the latest scientific news. Would it not be a good idea for these same journals to occasionally prod the public mind to a sense of its ignorance by presenting in a popular manner a few of the fundamental principles of electricity as well as other sciences.

In the course of a few years the training the public received would make them as familiar with science as they are with bimetallism; as ready to discover a fraud before it is perpetrated as after the harm has been done. We find that the Sunday editions of the daily papers have begun this good work, but not seriously. We therefore hope to find more attention paid to this great educational work by them in the near future. Frauds sometimes prey upon the public's purses in so insidious a manner that the police cannot interfere. Let the great newspapers warn and protect them from such reptilian criminals. That is undeniably one of their functions.

Grand Falls, N. B.—A company has been formed composed of Sir William Van Horne, Senator Proctor, of Vermont; Mr. Alger, Secretary U. S. Navy, and others, to develop the water power at this place and transmit electric power north to River du Loup, and south to Woodstock. The developing works are expected to cost $20,000.

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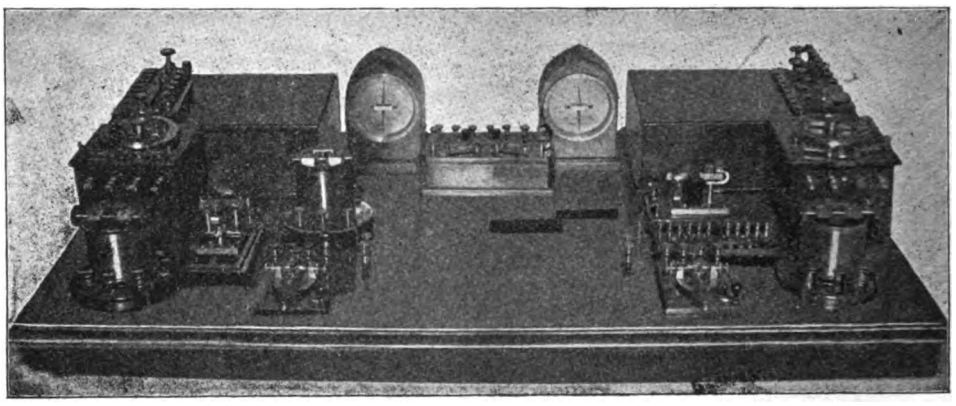
and less settled suburban districts the trolley has been a great success, while the cable is limited in its application on account of the great expense of running and installation. The line must be drawn, however, between those systems which distribute and those which transmit power.

The distribution of power is carried on at the extremity of or along a power line. The transmission, between two distinct centres.

A line stretching from Niagara to New York would be a power transmission line; from the heart of New York to its innumerable streets and adjacent districts, merely distribution would occur. The case that would come more closely in touch with the title of this article would be that of two widely separated centres between which a line is to stretch carrying power from one to another.



Line Testing Outfit.

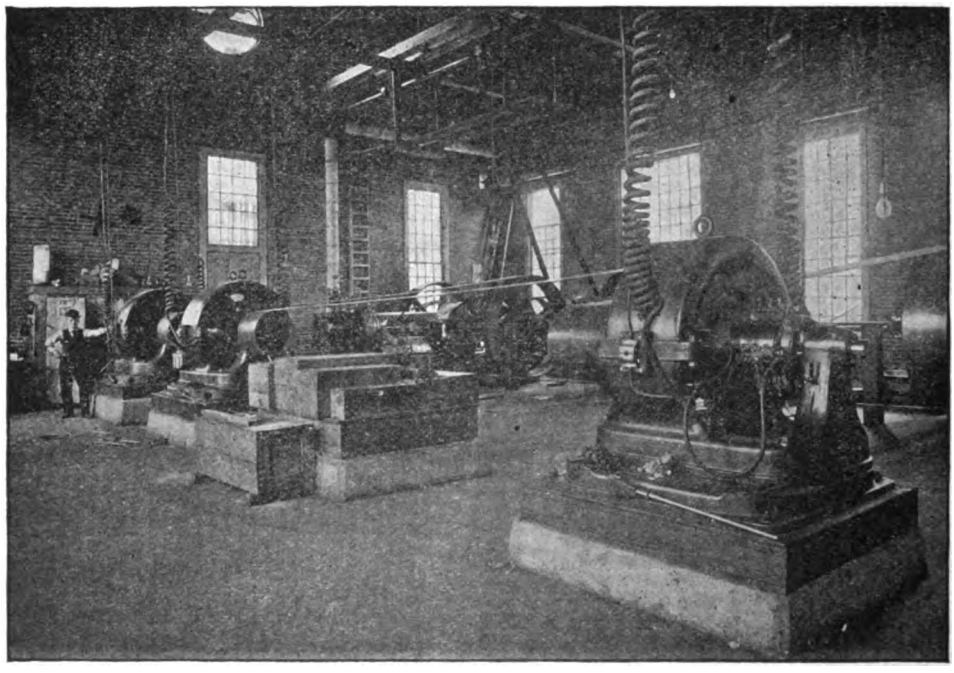
To determine the loss in power, weight of copper, volts required and general expense, is a problem having some weight in the transmission of power.

It is in reality all there is to the transmission of power, because it covers the most important points, touching all things from the standpoint of enonomy.

If an electric current could be sent at random over any line without the least attention being given to insulation, pressure or current, then the subject of transmission of power would never have been dignified by such a title. It should be the object of every engineer to send power from point to point with the least possible waste and expense. This happy combination is only secured by investigating the conditions that exist. The efficiency of a system of transmission might be affected by the distance, locality, etc. For instance, the efficiencies of a wire rope transmission plant of the following distances are given by Kapp:

Distance in feet,	300,	1,500,	3,000	15,000	30,000	60,000
Efficiency,	.96	.93	.90	.60	.37	.13

The same would naturally follow with any other source of power—that the greater the distance over which it extends, the greater the loss in power. As given by Herr Beringer and referred to by Gisbert Kapp, the following interesting table shows the relative efficiencies of each system:



Another View of Power Plant, Granite City Steel Company, Granite City, Ill.

COMMERCIAL EFFICIENCY.

Distance.	Electric.	Hydraulic pressure	Compressed air.	Wire rope.
300 ft.	69 per cent.	50 per cent.	55 per cent.	96 per cent.
1,500 "	68 "	50 "	55 "	93 "
3,000 "	66 "	50 "	55 "	90 "
15,000 "	60 "	40 "	50 "	60 "
30,000 "	51 "	35 "	50 "	36 "
60,000 "	32 "	20 "	40 "	13 "

Before 1891 these figures were compiled, and the line of electrical efficiencies is very much higher than the above to-day. It is not very difficult to send 1,000 horse-

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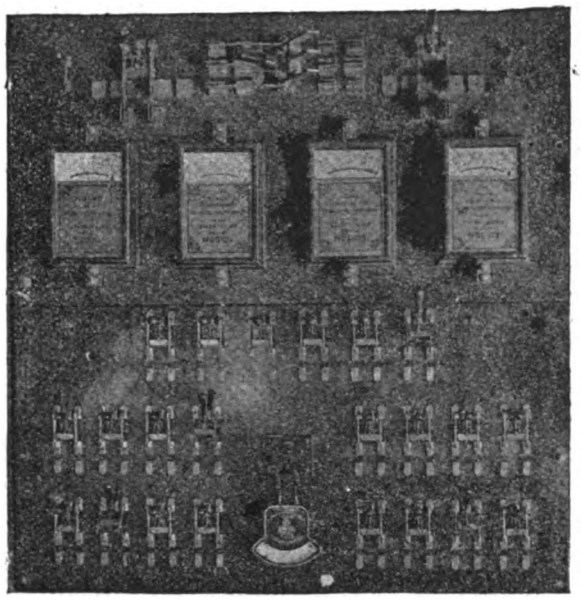
power a distance of 100 miles, 528,000 feet, at an efficiency of over 60 per cent. As an example of the limitations imposed by distance and material, take a copper line having 10 per cent. with drop machines at each end of 90 per cent. efficiency—that is, motor and dynamo—what is the efficiency of the system?

The dynamo at 90 per cent. loses 10 per cent. in the line; that is 81 per cent. left for the motor. If the motor has 90 per cent. efficiency, it returns as power 90 per cent. of 81 per cent., which approximates 72 per cent. in total. What conclusions may be drawn from this other than that if motor, dynamo and line each have only 10 per cent. loss, the system is of 72 per cent. efficiency over any distance as long as these conditions with a continuous current are observed.



General Arrangement of Power-Distributing Switchboard.

The latest feat of engineering has been the design and construction of a huge power plant at Niagara Falls. In Germany, between Frankfort and Lauffen, a line 100 miles long was extended. The power was generated at Lauffen. A turbine that gathered energy from the Necker River was used and a three-phase alternator.

The current generated was 1,400 amperes at 50 volts pressure. It was transformed before entering the line to 30,000 volts, and when received at the other end (Frankfort) again reduced to 60 volts. According to an official test, when 80,500 volts were sent out 58,000 were received; the efficiency being 72 per cent. This account of what may be considered the first experiment of any consequence in this direction gives satisfactory results. The distance over which the power was transmitted was 108 miles.

It is not difficult to attempt to transmit heavy power over long lines, as a precedent has been established which today may be looked upon as successful. The difficulty of using continuous current for long-distance transmission is that of transformation.

Power can be economically sent from point to point as long as the pressure is high. The efficiency of a plant depends upon the voltage of the line to a greater extent than anything else. Continuous-current dynamos use commutators which give rise to sparking troubles when high pressures are used. They cannot be safely connected in series, although the idea seems plausible, because the insulation is apt to give.

The economy of transmitting power is somewhat affected by the cost of the repairs. Weak machinery is as detrimental to a plant as poor insulation. There are no continuous-current generators in existence that could safely be used for high tension work. Such pressures, for example, as 10,000 or 20,000 volts. Not requiring commutators, and being easily susceptible to transformation, the alternator is at present superior to all as a generating device.

In 1881 Deprez, of France, proposed that the current be generated at a low pressure, raised to a high potential, sent over the line and reduced to a low pressure again for commercial purposes. To accomplish this, continuous as well as alternating-current transformers may be used. If the plant is a high-pressure continuous-current system, an increase or reduction in pressure is obtained by using a motor and a dynamo in one. The armature is wound twice—once for a motor to receive the power, and again as a dynamo with sufficient turns and commutator to produce the pressure required.

The machine is called a motor dynamo or continuous-current transformer. The armature having two windings and two commutators is expensive and unsatisfactory for this purpose, except in special cases.

On the other hand a transformer, as previously described, is a simple magnetic circuit interlinked with coils. The absence of moving parts makes its use extremely practical. The difficulty of insulating it has been well overcome.

In transmitting power by alternating current the choice that exists lies between—

Single-phase,
Two-phase,
Three-phase systems.

In certain respects the two-phase has many advantages, but the matter is still in abeyance.

It may be said, however, that single-phase transmission plants are entirely out of the question. This now leads us to the examination of the reasons for choosing between the three.

Before the multiphase motor was invented, the single-phase current could not run a large alternating-current motor unless it was first started by some other source of power and set into synchronism.

The introduction of two and three-phase currents, however, provided a means for overcoming this defect. Motors became self-starting when built on this principle and were introduced as a successful commercial feature of an alternating-current plant.

This, then, in total, may be considered the reason why alternating-current apparatus has become popular. The erection of a plant merely for the purpose of furnishing light is ridiculous, if conducted on a large scale. The transmission of power in one sense defines the object in view, and how is it possible to develop an enterprise so

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handicapped at the outset? Competition with continuous-current plants, even though such installations cost twice as much, would eventually drive from the field those advocating another principle, yet unable to meet all of its demands.

The transmission of power is successfully carried on with a high pressure, an easy transformation, efficient motors and good line insulation. Attention to these factors means attention to the very elements of success.

QUESTIONS FOR REVIEW.

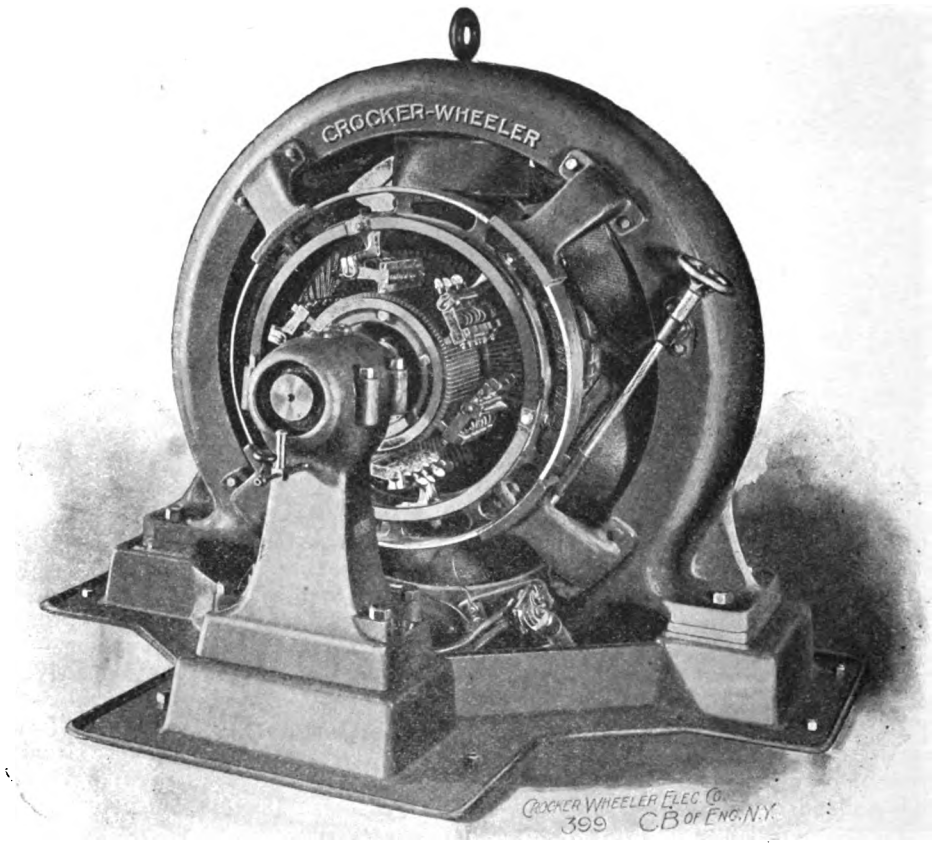
(1) How is power transmitted?
(2) What is a power transmission line?
(3) What system is most economical over short distances?
(4) Why is a high potential necessary for the economical transmission of power?
(5) What is the purpose of a motor dynamo?
(6) How is power transmitted by alternating current?
(7) What is meant by
Single-phase,
Two-phase,
Three-phase currents?

DYNAMO DESIGN.

The design and construction of dynamos and motors has been reduced to a science. Continuous current and alternating current machines are in daily use by the thousand for all purposes, including electric lighting, power transmission and distribution. The efficiency of a dynamo depends so largely upon a thorough knowledge of a few simple principles that it is absolutely impossible to build a machine of this description unless guided entirely by the experience of others and your own intelligence. In earlier days the mere generation of a current was considered remarkable; today the features of a modern machine are sparklessness, coolness in running and high efficiency.

The exclusive use of wrought and cast iron for dynamo construction is now an ancient practice. Steel frames are used in the majority of cases and the high permeability and lightness of this material makes it a permanent factor in dynamo construction. The most advanced builders of electrical machinery have led the way in the adoption of the multipolar type of frame for the generation of electricity on a large scale, also in the use of mild steel for the complete or partial construction of the same. It may be said that the body of the machine has grown lighter and the armature grown larger and heavier.

The illustrations added to this short sketch show in general the design of a Crocker-Wheeler dynamo of the multipolar type. Whereas the illustrations are not directly related to each other and do not represent the same machine throughout, they show certain points in construction which are interesting. In the frame the lack of any excess of metal is noticeable. Enough magnetic material has been used to carry the lines of force and no more. In the armature, provision has been made to properly transmit the lines of force from pole face to pole face and yet allow of sufficient ventilation and enough conductors to generate current and pressure required without crowding.



Type of the M st Modern Design in Generators.

Sparking at the commutator, according to the opinion of one of the founders of this company, is avoided by saturating the armature core, thereby preventing or neutralizing the effects of self-induction at the moment the commutator segments are short circuited by the brush. Sparking at the brushes may be traced to the size of air gap, ampere stream and strength of magnetic field. An adjustment between these three, if carefully made, will absolutely annihilate this disagreeable phenomenon. A design of the pole piece will, by producing the proper magnetic spray, assist in this reform of the ancient design. An allowance of sufficient radiating surface on both fields and armature will prevent the accumulation of heat. A machine that does not spark or unduly heat is one which is apt to be highly efficient.

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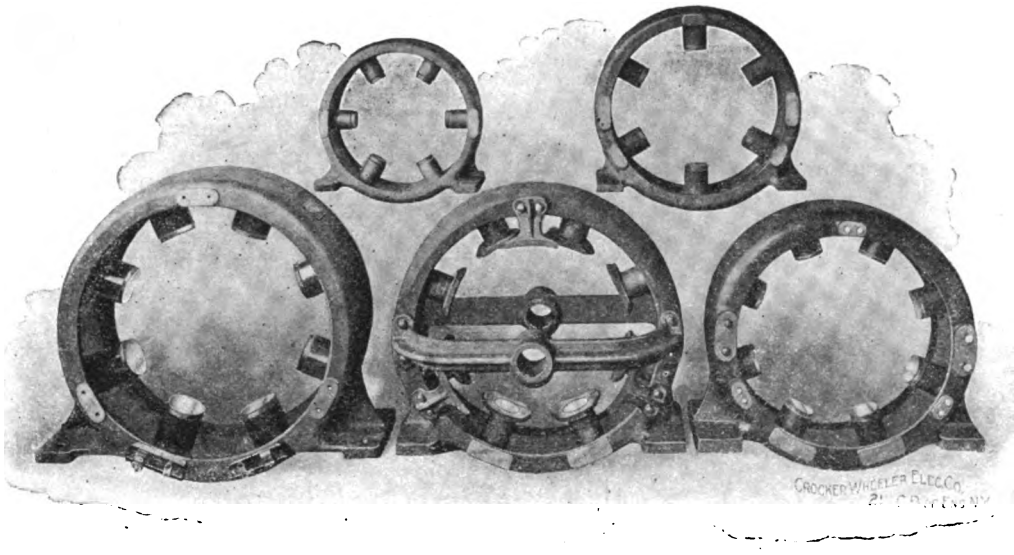
The absorption of power in any case is noticeable to such an extent that the point or location at which a loss occurs can be easily traced.

Commutator construction has been reduced to such a system that none of the faults they were at one time heir to exist any longer. Loose bars, projecting segments, poor insulation or quickly wasting metal are no longer in vogue. The perfection of the commutator from a mechanical standpoint has had its influence in prolonging the life of a machine and gaining public confidence in its commercial application. With steel fields, a well laminated slotted armature and a large radiating surface the three most pressing requirements are met with, and the possibility of constructing an efficient and lasting piece of machinery is quickly assured.

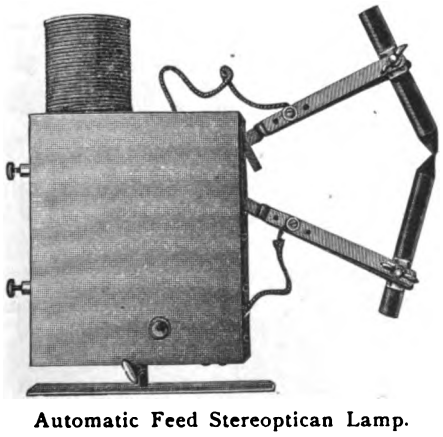
In conclusion it may be stated that efficiency does not hold a candle to durability. The struggle that has gone on to gain a few per cent. this way is a useless one. Good design will bring with it the highest practical efficiency, and if associated with intelligent mechanical construction it will certainly lead to the production of a generator whose period of active service may be almost indefinite.



Field Frames, composed of Cast Iron Yokes and Mild Steel Cores.

THE MODERN MAGIC LANTERN AND ITS ELECTRICAL IMPROVEMENT.

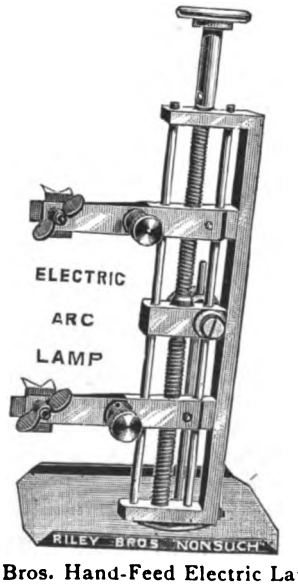
The magic lantern has been blessed with as many names as some of the titled grandees of Spain, but it has remained, in spite of these sobriquets, a source of enjoyment to the great multitude, which is, to say the least, remarkable. In its varied forms it appears, with different degrees of mechanical elaboration, as the stereopticon, the ethopticon, the polyopticon, etc., in addition to those compound types which produce dissolving views. As far as the electrician is concerned, the stereopticon or magic lantern has met with improvements which are entirely due to his interest in their development.



Automatic Feed Stereoptican Lamp.

The introduction of the arc light for lantern use and the invention of the kinetoscope brought the attention of the world to the high state of perfection these instruments had arrived at. Riley Brothers, of 16 Beekman street, New York, with offices at 55–57 Godwin street, Bradford, England, and 22 George street, Dunedin, New Zealand, have carefully developed their business in this class of apparatus in every possible direction. As a result of their study and attention to its details, they stand in the position of authorities on the subject of stereopticons, magic lanterns, etc., being prepared to give all information relating to the same. Some illustrations of the apparatus they handle are to be found in this article. Dissolving view lanterns and those fitted with hand feed electric lamps are brought to the reader's attention. A form of portable lantern is presented which has met with great success. Likewise the kinetoscope they pay special reference to.

The lenses, mechanism, superior finish and magnificent slides sold by Riley Brothers have won world-wide renown for them in every civilized centre on the globe, and we advise our readers interested in this class of apparatus or contemplating purchases to write to this concern at the address given, 16 Beekman street, New York city.



Riley Bros. Hand-Feed Electric Lamps.

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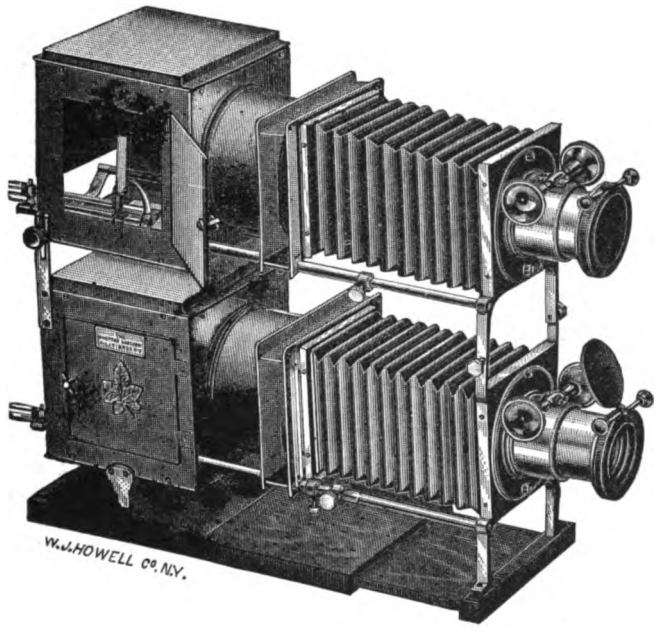
DEVELOPMENT OF CENTRAL STATIONS.

(Continued from page 96.

It is not my wish to address you on the scientific or technical side of central station development. I have thought it necessary to go at length into the early work of the art more for the purpose of giving you some idea of the position to which Mr. Edison is entitled as the father of central station work. My limited knowledge of the technique of the business would not permit me, even if I wished, to discuss the details of his early work, or of the early work of other experimenters; but I assure you that



The Pastor's Portable Lantern.

daily familiarity with the operation of one of the largest central stations in this country gives me a higher and higher appreciation of the simplicity and thoroughness and adaptability to all purposes of electrical distribution of the great work accomplished by the "Wizard of Menlo Park."

As a result of the experiments at Menlo Park Mr. Edison, early in the winter of 1880, started to get together the necessary data for the establishment of a central station and distributing system in New York, in the district bounded by Wall street on the south, Nassau street on the west, Peck Slip on the north, and South street on the east, a territory covering about 2,000 feet square. He had each house thoroughly canvassed to show the number of lights in use, the number of hoistways and elevators, and the horse-power of the engines running machinery. You will find on the walls around us the blue prints of these original canvasses.* On one blue print you will find an enumeration of the power in use in that district, and on the other blue print a record of the lights there used. As a result of this canvass, the Edison Electric Illuminating Company of New York was formed and drawings prepared for a central station, which was erected at 255 and 257 Pearl street, the capacity of the station being 2,000 horse-power, and the district fed by a system of half-round copper mains and feeders, the mains being enclosed in lengths of iron pipe and insulated by a bituminous compound, each length of main being between twenty and twenty-one feet, so that it was possible to take off a service at each house.

Time will not permit me to go into the details of construction of this, the first central distribution station. You will see, by referring to the outline drawings of the station which I have with me, that the boilers were placed down below and were of the horizontal water-tube type, made by Babcock & Wilcox, carrying a pressure of 125 lbs., the steam machinery and dynamos being of the direct-connected type and placed on a steel structure not dissimilar to that of some portions of the elevated railroad structure in New York.

Great care was taken in figuring out the system of mains and feeders, an immense plot of the district being represented by a series of resistances showing in miniature the probable consumption of current in the various parts of the district. It should be remembered that the path to be followed was practically unknown, that electrical distribution on a large scale was as much of a hidden secret as an unexplored continent, and the remarkable thing is that this first experimental system was a practical success, and a return on the money invested was being earned before electricians at home and abroad would recognize the success of the undertaking. It is but natural that many devices were used which were subsequently absolutely discarded. For in-

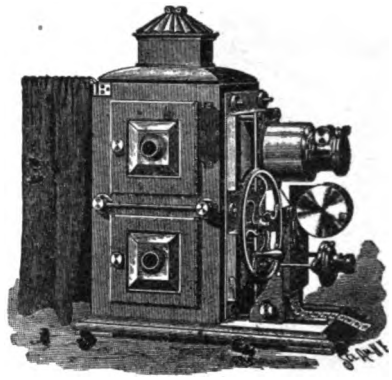


Fig. B.—Cinematographs.

stance, an elaborate system of resistances placed in series with the feeders was employed for maintaining an even pressure, entailing a considerable waste of energy. The lamp employed was not more than one-half as efficient as that used to-day, while the cost of manufacture was many times greater, and it had not one-quarter of the life of the present commercial incandescent lamp.

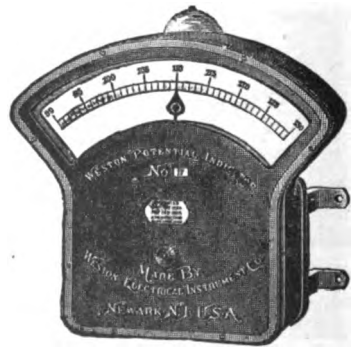
(To be continued.)

*The charts, curves, and drawings referred to in the lecture are part of the confidential records of the Chicago Edison Company and the Edison Electric Illuminating Company of New York. It is therefore impossible to publish them.

Brantford, Ont.—The city has decided to dispense with gas for lighting purposes, and will ask tenders for electric light; also for installing an electric light plant to be controlled by the city.

Quebec, Que.—It has been decided not to extend the electric railway to Montmorency this year, but everything will be in readiness to change the system from steam to electricity next year.

WESTON STANDARD ILLUMINATED DIAL STATION INSTRUMENTS.



THESE INSTRUMENTS are based upon the same general principle and are just as accurate as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger, and the working parts are inclosed in a neatly designed dust-proof cast-iron case, which effectively shields the instruments from disturbing influences of external magnetic fields.

WESTON ELECTRICAL INSTRUMENT CO.

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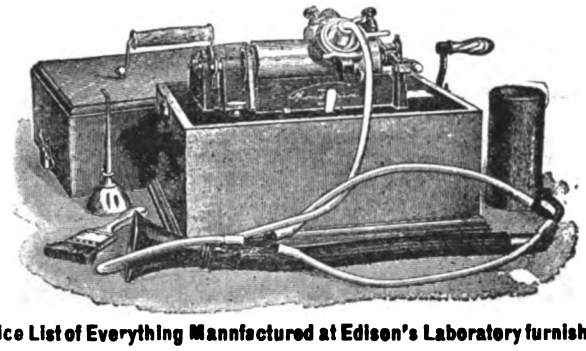

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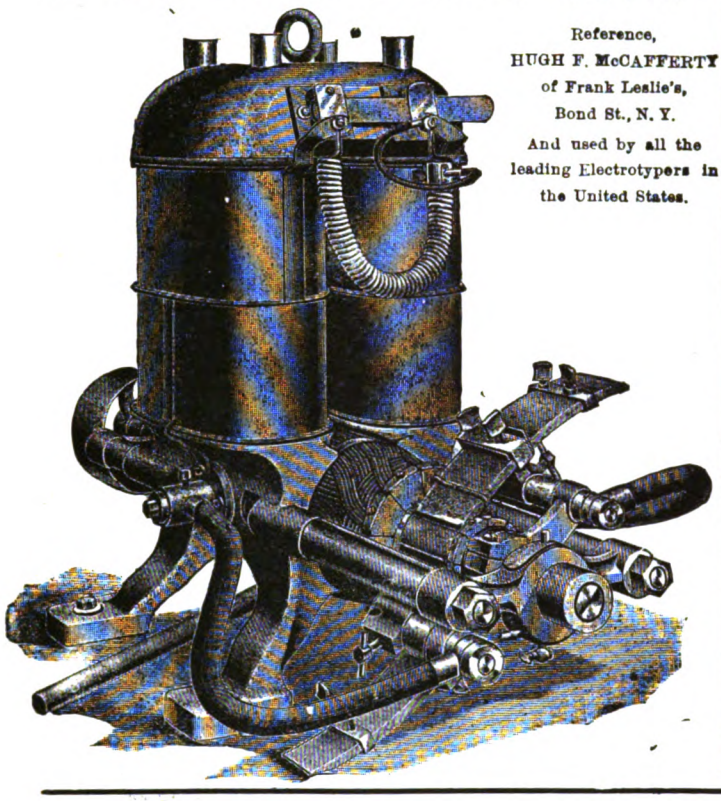

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And used by all the leading Electrotypers in the United States.

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ROOT IMPROVED WATER TUBE BOILER.

Selected by leading Electric Light Plants and Street Railway Companies throughout the United States. The following are the acknowledged requirements in water-tube boilers: *Straight tubes which can be thoroughly inspected and cleaned inside and outside; perfect suspension, allowing free movement of whole boiler expanding and contracting; perfect flexibility for the difference in expansion between upper and lower tubes; interchangeable parts, built to fixed standards; facilities for making quick and easy repairs which can be done by your own engineer or machinist; a cover joint which can easily be made tight, and frequently broken and replaced without injury; provision made to introduce the feed water where it will not chill and moisten the steam; provision made to carry feed water impurities direct to the mud drum and not past the ends of the tubes; provision made to supply the lower tubes with a bountiful supply of cool water; the use of the best materials and fittings the market can afford; the best possible workmanship; a large disengaging surface for the steam to escape from the water; small cast iron pressure parts; ample heating surface to prevent injury to parts should boiler be forced above its rating.*

Examine these Points in the Improved Root Water-Tube Boiler.
Send for our Illustrated Catalogue.

ABENDROTH & ROOT MFG. CO., 28 CLIFF ST., NEW YORK CITY.

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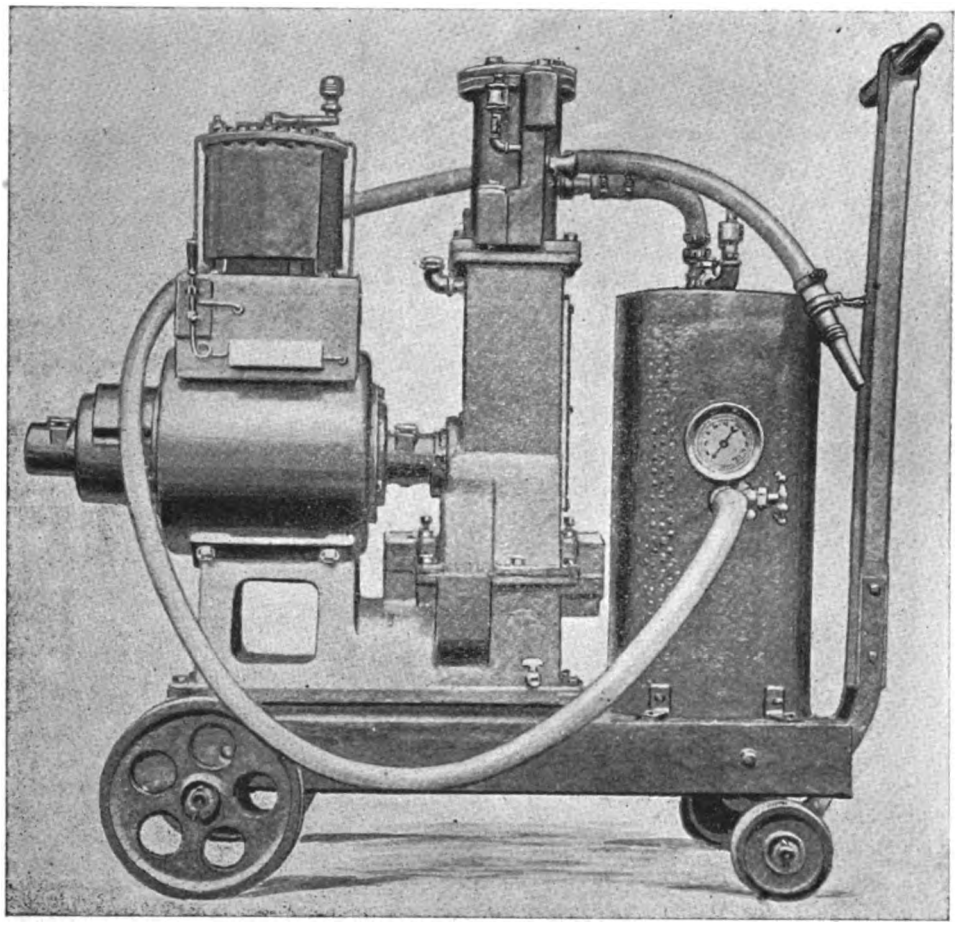
The Electrical Age.

VOL. XXII—No. 9 NEW YORK, AUGUST 27, 1898 WHOLE No. 589



New Portable Air Compressor, Belt or Motor Driven.

THE HUNT AIR BRAKE SYSTEM.

The phrase "up-to-date" is merely one exemplifying a state of mind or grasp of conditions which shows an inherent desire to be modern, alive, awake to the requirements of the hour. Since the public have expressed their belief in the advisability of having as much rapid transit as possible, the Hunt Air Brake Company, of New Kensington, Westmoreland County, Pa., have developed a system of braking street cars which possesses many unique characteristics and represents in every respect that "up-to-date" quality previously defined. The control of a car in a ready and efficient manner by means of air pressure or by mechanism operated thereby is so great a necessity at present that the adoption of this system for street railway purposes was a pressing necessity to all.

From a technical standpoint, the Hunt air brake consists of these parts: A pump furnishing compressed air, a reservoir for its reception, an automatic regulator controlling the pressure of air in the reservoir, a three-way valve regulating the flow of air from the reservoir to the brake cylinder; the pressure gauge, indicating the tension of the air in the reservoir; a brake cylinder operating by means of its piston rod upon a lever which sets the brake, an eccentric attached to the car axle operating the pump and by this means keeping up the air supply, and a hose used for connecting on to trail cars. In the illustrations appended to this article are shown a special form of portable air compressor used for rather a different purpose, but representing interesting features of construction to which reference will be made later on.

This air compressor is used for general pneumatic work Possibly the piece of apparatus possessing the greatest interest to the electrical engineer is the automatic pressure controller, by means of which the air pressure entering the reservoir is absolutely controlled and the motor on the car protected from sudden rises of pressure. This is possible in this device by allowing the resistance to be gradually cut out every time the compressor is started. This controller is the only one in existence which automatically interferes, protecting the motor in case the trolley slips off or the current be discontinued while the compressor is in operation. The automatic pressure controller is adjustable for any pressure, breaks the circuit at two points instantaneously, is equally serviceable for automatic or straight air, and requires no attention from either conductor or motorman.

The air compressor finds its use for power house station cleaning. It is driven by a motor taking two hundred and fifty volts pressure, or higher or lower to suit. A steel tank two feet high registers pounds per square inch. The pump has a four-inch cylinder, four and a quarter inch stroke, and is operated by a two-horse power series-wound motor. The air supplied by this machine may be led to the commutator of the dynamo or used for whatever purpose required. In the illustration the compressor of the series B type is mounted upon a wood frame with iron axles and wheels. The vertical reservoir is firmly bolted. Vibration cannot be taken up, and no mistake is possible in connecting motor up, as the binding

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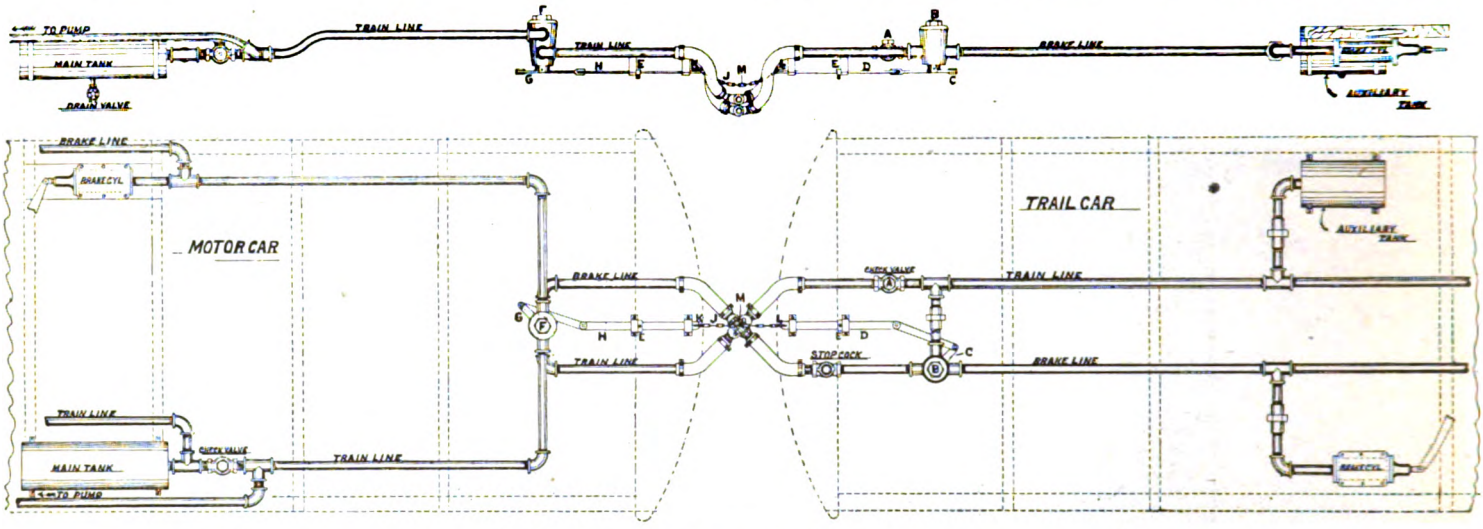
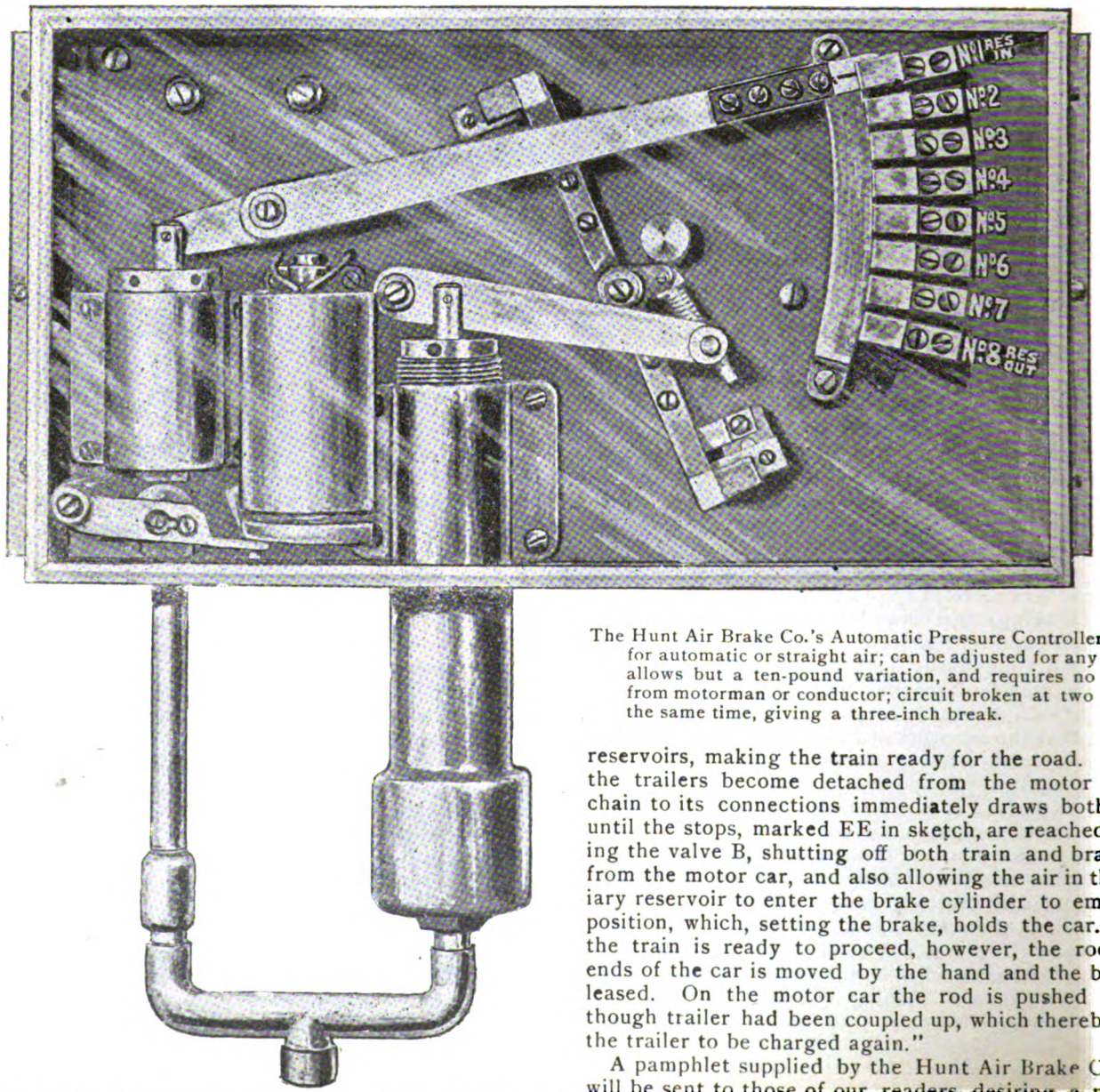
posts are stamped positive and negative. All moving parts operate in oil, and everything is ironclad. About ten feet of hose is all that is required to operate this device.



The Hunt Air Brake Company's New System for Automatically Setting the Brakes on Trail Cars should they Become Detached from the Motor Car.



The Hunt Air Brake Co.'s Automatic Pressure Controller; adapted for automatic or straight air; can be adjusted for any pressure; allows but a ten-pound variation, and requires no attention from motorman or conductor; circuit broken at two points at the same time, giving a three-inch break.

The diagram represents a new system for automatically setting the brakes on trail cars in case accident detaches them from the motor car. The value of this combination is evident to our readers. To quote, the operation of the system is as follows: "After the train has been made up and coupled the compressor is started, charging both reservoirs, making the train ready for the road. Should the trailers become detached from the motor car, the chain to its connections immediately draws both valves until the stops, marked EE in sketch, are reached. Opening the valve B, shutting off both train and brake lines from the motor car, and also allowing the air in the auxiliary reservoir to enter the brake cylinder to emergency position, which, setting the brake, holds the car. When the train is ready to proceed, however, the rod at the ends of the car is moved by the hand and the brake released. On the motor car the rod is pushed back as though trailer had been coupled up, which thereby allows the trailer to be charged again."

A pamphlet supplied by the Hunt Air Brake Company will be sent to those of our readers desiring a more detailed account of this system than our space will allow.

The combined motor compressor illustrated herein is

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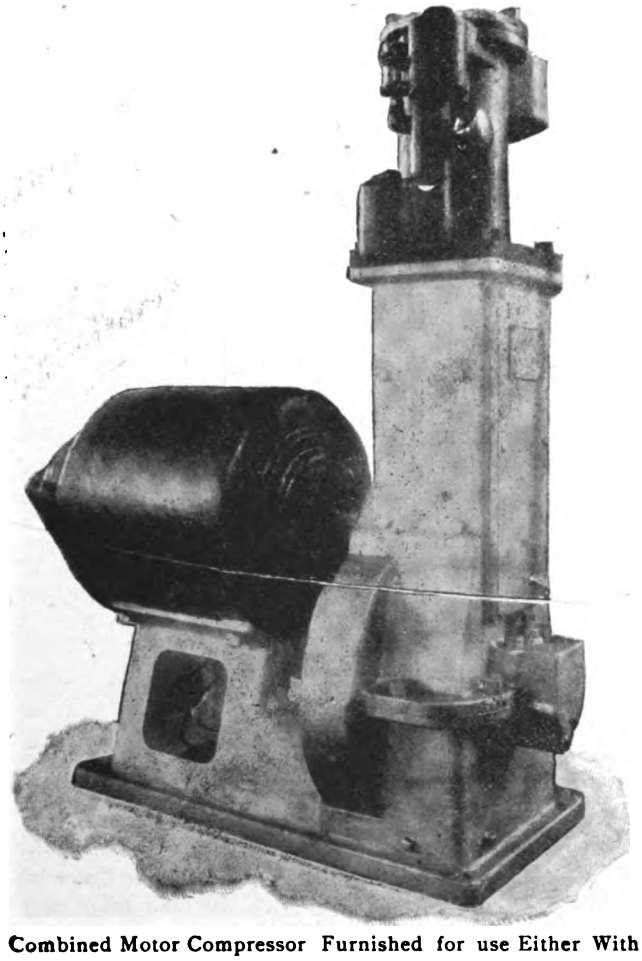
used for heavy, double-truck electric cars. It is carried upon a platform or vestibule, or partially suspended below the floor line, if necessary. The pressure of air in the reservoir is absolutely controlled by the automatic controller. The size of the compressor is thirty inches long, twelve and one-half wide, and thirty-four inches high. The series B type delivers eight cubic feet of free air per minute; series E, eleven and one-half; series C, thirteen; the weight and size of each being about the same. A rather larger size called series D is used for special purposes, such as those requiring automatic air, etc. A delivery of thirty cubic feet of free air per minute is possible in this case.

A car controlled by this apparatus is one which may be almost instantly stopped, and is safer to the pedestrian at a high speed than those equipped with ineffective devices running at a lower speed.

It is not necessary to dilate further upon the advantages of an ever-ready and accident-preventing brake, but it is well to point out that system and mechanism which seems to represent in its embodiment those desirable features of definite value and immediate application. The subject of air brake and mechanism related to it is an extensive one, but in spite of the scientific attention it has received, the development of the art of air brake manufacture has only lately attained its maximum. It is fortunate that such is the case, for in the near future our cars will fly through the city limits, and the necessity for a system of braking as herein described will be, as it is today, a crying one.



Combined Motor Compressor Furnished for use Either With "Straight" or "Automatic Air."

THE LIMITATIONS OF GOVERNMENT IN WATER-POWER PLANTS.

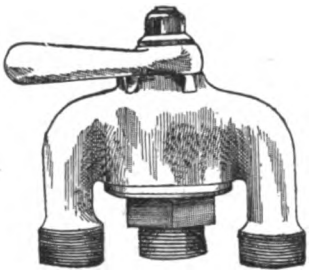
BY MARK A. REPLOGLE, ENGINEER.

The regulation of the speed of a water-wheel in a power plant is determined by four distinct factors:

1. Changes in load or requirements for power;
2. Time required for gravity to generate power;
3. Capacity of the plant for stored energy; and,
4. The governor or mechanism that should automatically combine the above three factors in such a manner as to obtain even speed or good regulation. These factors, clearly defined, are bases from which intelligent calculations can be made showing the possible efficiency of government in any water-power plant.

Let it be understood that the word "government" refers to that regularity of motion or speed that is so desirable and necessary in our finest manufacturing and electrical power plants. Absolutely uniform speed can be maintained only when there is no change in the power supply and no change in the friction or work of the plant; but if the above factors are carefully considered and judiciously manipulated or applied, the variations of speed may be so reduced that the results can be called perfect government.

The speed of a plant at all times is a resultant of opposing forces establishing an equilibrium or balance. The power supply has a tendency to increase speed and the work has a tendency to decrease it. Speed may be varied by increasing the power supply or by decreasing the power supply; by increasing the amount of work performed, or by decreasing the amount of work performed; and any one of the above changes causes instantly a change in the speed; but the amount of change in speed depends entirely upon the amount of change in load, the time it takes gravity to generate power, the quantity of energy in store, and the operation of the governor in opening or closing gate.



Hunt Air Brake Co.'s Three-Way Valve.

Since it is impossible for any automatic governor to change the power supply at the instant a change has been made in the load or work of a power plant, it is very plain that there must be fluctuations in the speed. The problem of government is to narrow these fluctuations to such an extent that the speed will be constant as far as practical operation is concerned. The finest government ever obtained consisted of changes in speed, but within narrow limits. The speed of a well-governed single-crank engine changes four times every revolution.

The first factor in governing, "the changes in load," is a variable one, and is limited only by the character of the work done by the water-wheel. The changes may range from zero to the full power of the wheel instantly, making government a more difficult problem than it would be if the changes were limited in number or quantity. It is plain that if an even speed is retained when a change in load is made, there must be at the same instant a corresponding change in the power supply. This is an impossibility in automatic governing, for several reasons: the speed must change in order to inspire the speed governor; following this, the speed governor causes the valve or gate-moving mechanism to operate, which operation requires time; and, again, it requires time for gravity to overcome the inertia of the increased quantity of water that must pass through the wheel before an increase in power can be had. During all this time, the speed of plant has been decreasing if the load was increased, or increasing if the load was decreased, and the amount of change in speed depends entirely upon what

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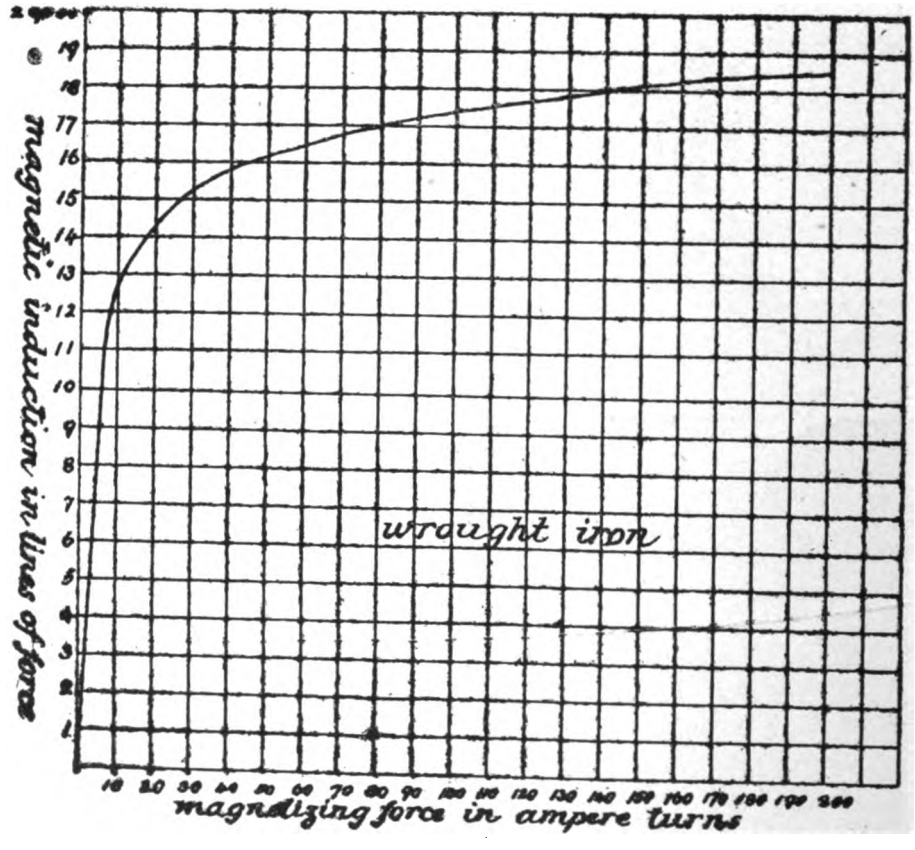
ratio the change in load bears to the stored energy in the moving parts of the plant. A heavy change in load will of course cause a greater change in speed before the power supply is changed, than a light change in load. The problem is, therefore, to proportion properly the power-storage to the changes of load that must be imposed upon the plant, because this power storage, or the capacity to store power, must take care of all changes in load until the power supply, or gravity effects, can compensate for said changes.

The second factor, "time required for gravity to generate power," is more constant than the first. In fact, the limits are established in the construction of the water-power plant, and, of course, remain so. The point we wish to emphasize most in the time requirements is the inertia and momentum effects of the water.

It is well known that water has practically no elasticity; hence, if enclosed in a long pipe, the whole body must be put in motion at the same time. If the pipe or flume consists of several hundred feet of horizontal length and only a few feet of vertical pipe or "head" which alone gives gravity effects on the wheel, it is a similar proposition to the locomotive and train of cars. It is very evident, then, that long horizontal pipes should be avoided in order to reduce to a minimum the time required to get gravity effects, because the speed of water-wheels will keep changing, after a change in load, until the effects from gravity can correct it in the power supply.

Gravity effects at best are very slow as compared with steam, and for this reason a water-power is handicapped in the matter of government. The logical conclusion is, that in water-powers the water or power supply should all be



Magnetization Curve of Wrought Iron.

A locomotive can propel a train of cars at a rapid speed; but it takes time to acquire such speed. When the locomotive has brought enough pressure to bear upon the train, it moves, at first slowly, but keeps increasing in speed often many seconds before it reaches full motion. The locomotive may be limited in strength to 250 H. P. per second. The train in full motion may represent 25,000 H. P. for a second. In such case, it will take the locomotive 100 seconds to bring the train to speed if we do not consider the frictional losses. Water has no power in itself; but must be put in motion by gravity in the same manner that the locomotive starts the train of cars, and a long train of water acted upon by a constant gravity effect, is put in motion in the same manner that the train of cars is by the locomotive. It is plain, then, that the time element must be considered in the government of water-power. The water-wheel cannot furnish power until it brings to rest the water to which gravity has given motion, and it can receive no power from the water until the water has sufficient motion for the moving wheel to retard. It is also plain that there must be changes in the flow and velocity of water for every change made in the load of the water-wheel; also the change in the flow of water must occur before there can be a change in the power supply.

under the direct action of gravity and move in line with it. This reduces the time necessary to furnish increased or decreased power to the shortest limit.

DESIGN OF ELECTRO-MAGNETS.

To produce in a given cross section of iron a certain specific induction is one of the commonest practices in electrical engineering. The line of force spoken of in this case differs quantitatively from the line of force whose course is shown by iron filings. All lines of force are of equal value, but those lines represented by magnetic curves vary from each other in many respects. It is not a difficult matter to determine the size of wire and number of ampere turns required to make a magnet suited for practical work. Always allowing a specific induction in steel of eighty thousand lines of force per square inch, a specific induction in wrought iron of one hundred thousand lines of force per square inch, and a specific induction in cast iron of fifty thousand lines of force per square inch, we find that we need thirty-four ampere turns per inch length for cast steel, ninety-one ampere turns per inch length for wrought iron and one hundred and sixty ampere turns per inch length for cast iron.

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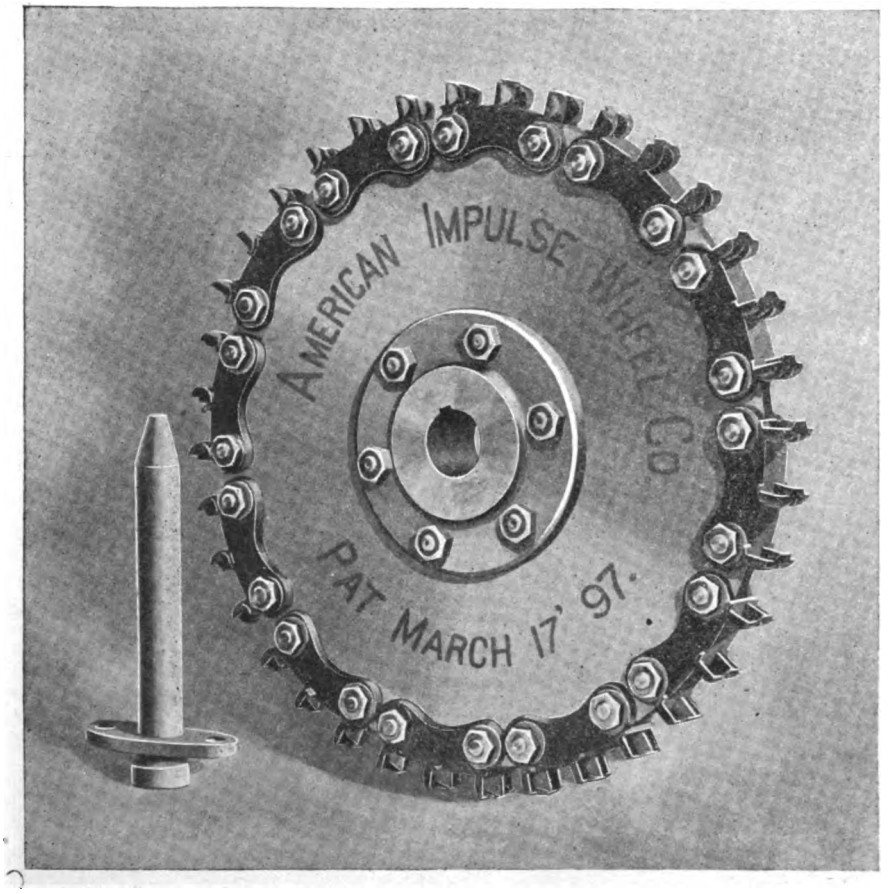
The original Hopkinson curve for wrought iron per square centimetre is given below. Its use is obvious. An electro-magnet built to carry five amperes having a core cross section of ten square inches and a length of five inches would be handled in the following manner: The core being of wrought iron saturated will carry one hundred thousand lines of force per square inch, or ninety-one ampere turns per inch length. As the core is five inches long, four hundred and fifty-five ampere turns are required. Allowing one thousand circular mils per ampere, five thousand circular mils will be used, giving a size of wire equal to No. 13. The turns are equal to four hundred and fifty-five divided by five, equalling ninety-one. The general features presenting themselves result in the conclusion that ninety-one turns of a No. 13 B. & S. will supply magneto-motive force enough to produce one million lines of force in the core.

Although this subject is capable of more detailed expansion, the important points to be observed are sufficient radiating surface or an allowance of two and one-half inches per watt, the required number of ampere turns to bring the lines of force through both armature and field as well as air gap, and a selection of a wire whose size will limit the resistance, consequently, the current and heat waste, to its proper value. The amateur designer, whose line of reasoning does not embrace all details, will always find it convenient and save time to allow one thousand circular mils per ampere in his wire and a radiating surface of at least two and a half square inches per watt.

Measurement of Streams—Weir Dam Method.



Special 18-in. Steel and Phosphor-Bronze Wheel, Used Under 700 lbs. Pressure.

At some future date a complete series of articles will appear in these columns treating of the design of a

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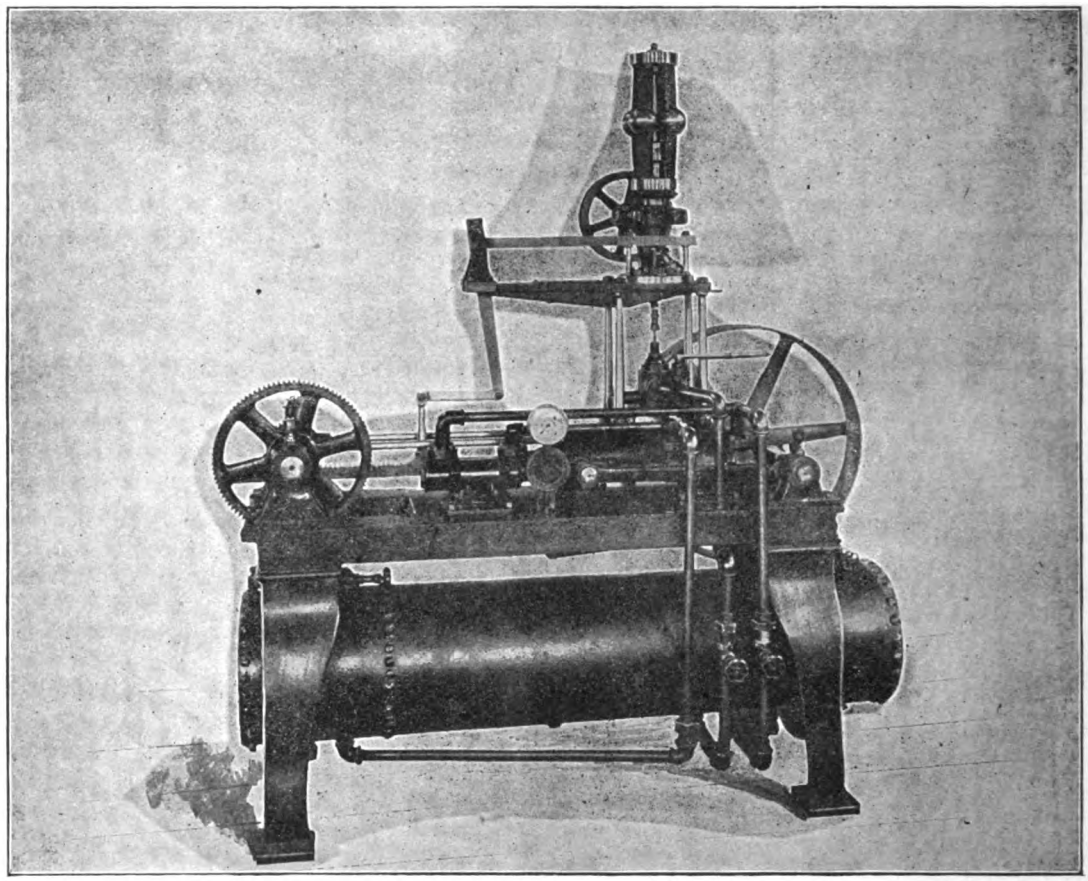
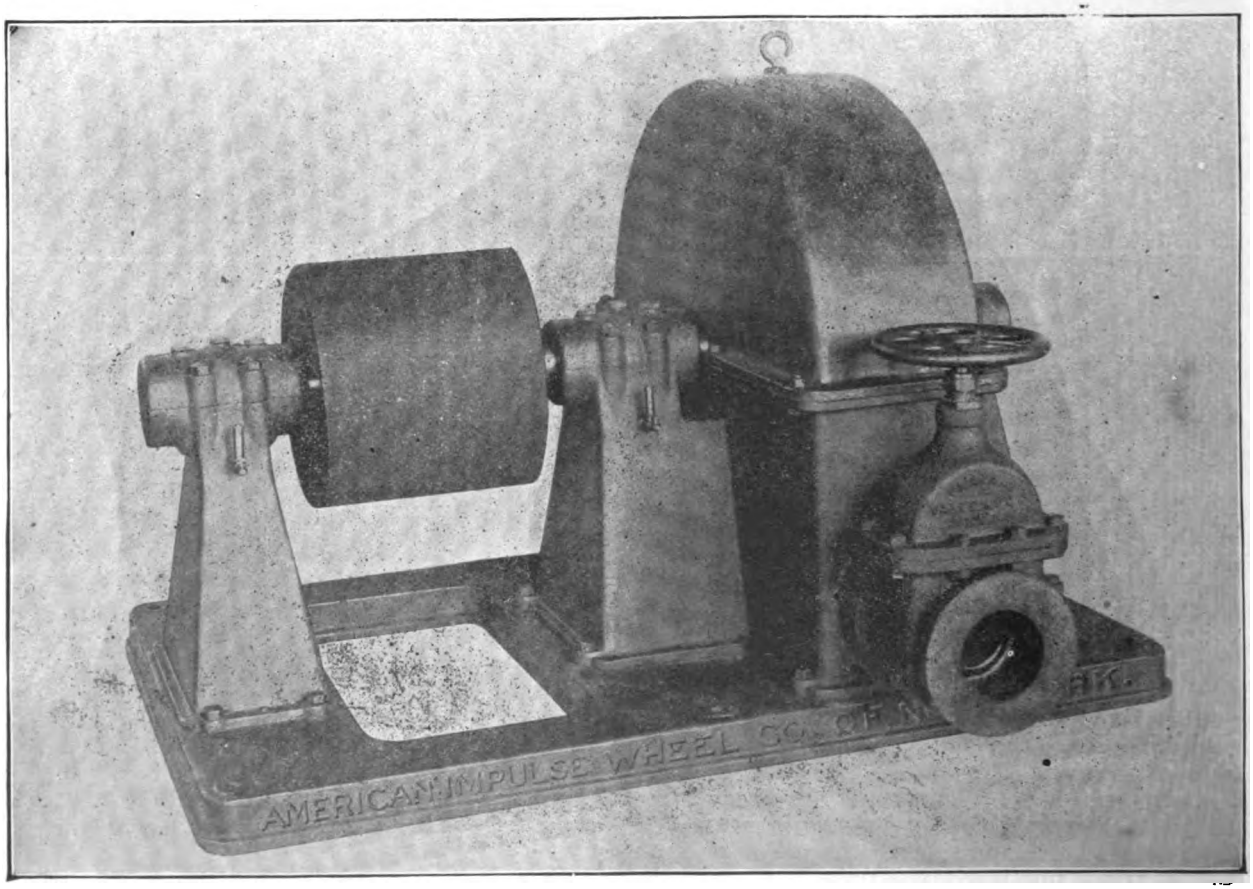
dynamo in a simple and comprehensive manner, in which no more complex mathematics will be required than those involved in the use of addition, subtraction, multiplication and division.

IMPULSE WATER WHEELS.

The subject of water wheels has been of the deepest interest to mankind from time immemorial. The wind



Lombard Governor—Type A.



Standard 36-in. Wheel, No. 5.

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NEW YORK.

NEW YORK, AUGUST 27 1898

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ELECTRIC RAILROADS IN CHINA.

The Celestial Empire is beginning to break away from its ancient practices and forgetting its time-honored traditions. Surrounded as it is by a wide circle of civilized nations, it is succumbing to their influence and betraying an interest which threatens to become an anxiety to march to the front ranks and occupy a place with others in the vanguard of progress. The foreign devils are soon to meet with gratitude from the Chinese, instead of suspicion, and the sea of ignorance in which this race has lived for ages untold will be agitated to its uttermost depths by a new force proceeding from civilized sources. The city of Shanghai is about to have installed in it an electric railway. It will be eighteen miles long and represent the ordinary type of trolley road. The city council have drawn up a report of their proceedings, as follows:

The report of the special commission is again under discussion and it is decided to include in the particulars both systems of gauge ("standard" and "meter").

The following general particulars are ordered for publication:

The electric overhead trolley system is to be adopted.

The routes are to be three in number, viz:

(1) From the French water works along the Chinese Bund (if practicable), and thence along the French and English Bunds, to the point by way of Broadway, Seward, and Yangtzepoo roads.

(2) From the Bund to the Bubbling Well, by way of the Kiukiang, Kiangse, Hankau and Nankin roads.

(3) From the Shanghai station of the Woosung-Shanghai Railway to the west gate of the Chinese city.

A concession is to be given for the construction of the line and all accessories to a syndicate or company, to be known as the "Shanghai Tramway Company." The concession is to be for thirty, forty, or fifty years, according to the tender that the ratepayers may decide to accept, and the company is to pay the council a percentage of the total gross receipts for the period of the concession.

Notification to tenderers by public advertisement will follow in due course, and the tender finally accepted will be submitted to the ratepayers for ratification.

We can certainly feel that with the installation of this road in Shanghai immense commercial possibilities open up to the manufacturers of America and England. We have frequently noticed that the first real taste of civilization in the way of innovations is intoxicating. A feverish desire takes hold of the people, as in the case of the Japanese, to have everything new, and we anticipate the same in relation to China, whose capacity for improvement is almost immeasureable. American manufacturers, with their wonderful facilities for turning out high-grade machinery, will discover in time a field for their goods which may make them strain every nerve to keep pace with the demand.

The producing nations have been supplying each other in the past, but the time has arrived for them to turn their attention to a land populated by nearly one-half the world's inhabitants, a people in whose breasts a love of the new is beginning to grow, which, if properly cultivated, will cause a social reform of an extent hitherto unequalled in the world's history.

AMERICA SUPERIOR IN THE MECHANIC ARTS.

One effect of the Spanish-American war has been to give Europeans a better knowledge of the ability of the United States to manufacture instruments of precision. American watches and clocks have long been regarded as marvels of correctness in time keeping; but, as was recently stated by a leading Frenchman, "America has astonished the world with the accuracy of her implements and machinery; her steel ships resist and endure better than those of other and older countries. Her intricate machinery does not get out of order so quickly and stands crucial tests far beyond the power of European apparatus, and there are fewer failures, because there are fewer defects; this is due to her implements of precision." It would be well to take advantage of this reputation and show what can be done by the American workmen; especially in the line of engines, locomotives, tools for cabinetmaking, all sorts of die-cutting machinery, and machines used in the manufacture of firearms of all classes. As France is seeking more and more to do her own manufacturing, she will naturally turn to the countrty that can sell her the best machines to accomplish her aims. These kinds of machinery should be well represented in France at all exhibitions.

A careful study should be made, not only of the needs of the French market, but of the best and quickest way of meeting them.

As has often been stated, the best man to do business for America is an American speaking the native tongue of the country to which he is sent. He will do more in less time, and do it more satisfactorily, than any foreigner.

Walter T. Griffin,
Limoges, July 19, 1898. Commercial Agent.

DEMAND FOR COAL BY BRAZILIAN GOVERNMENT.

The Department has received a cablegram from Minister Bryan, dated Petropolis, August 8, 1898, to the effect that the Brazilian Government intends to advertise for 120,000 tons of coal bids to be opened in October. Mr. Bryan desires that United States exporters should be informed of this opportunity.

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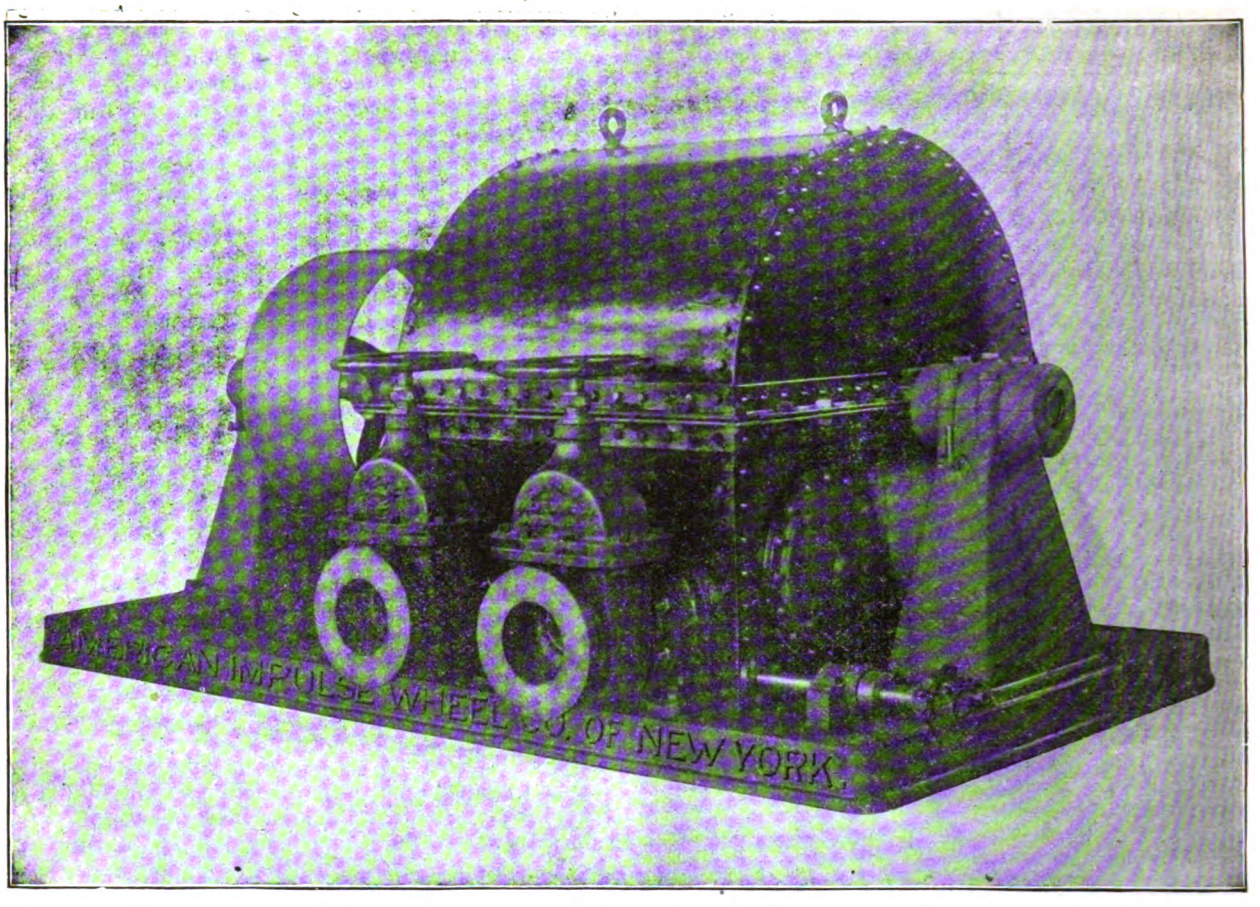
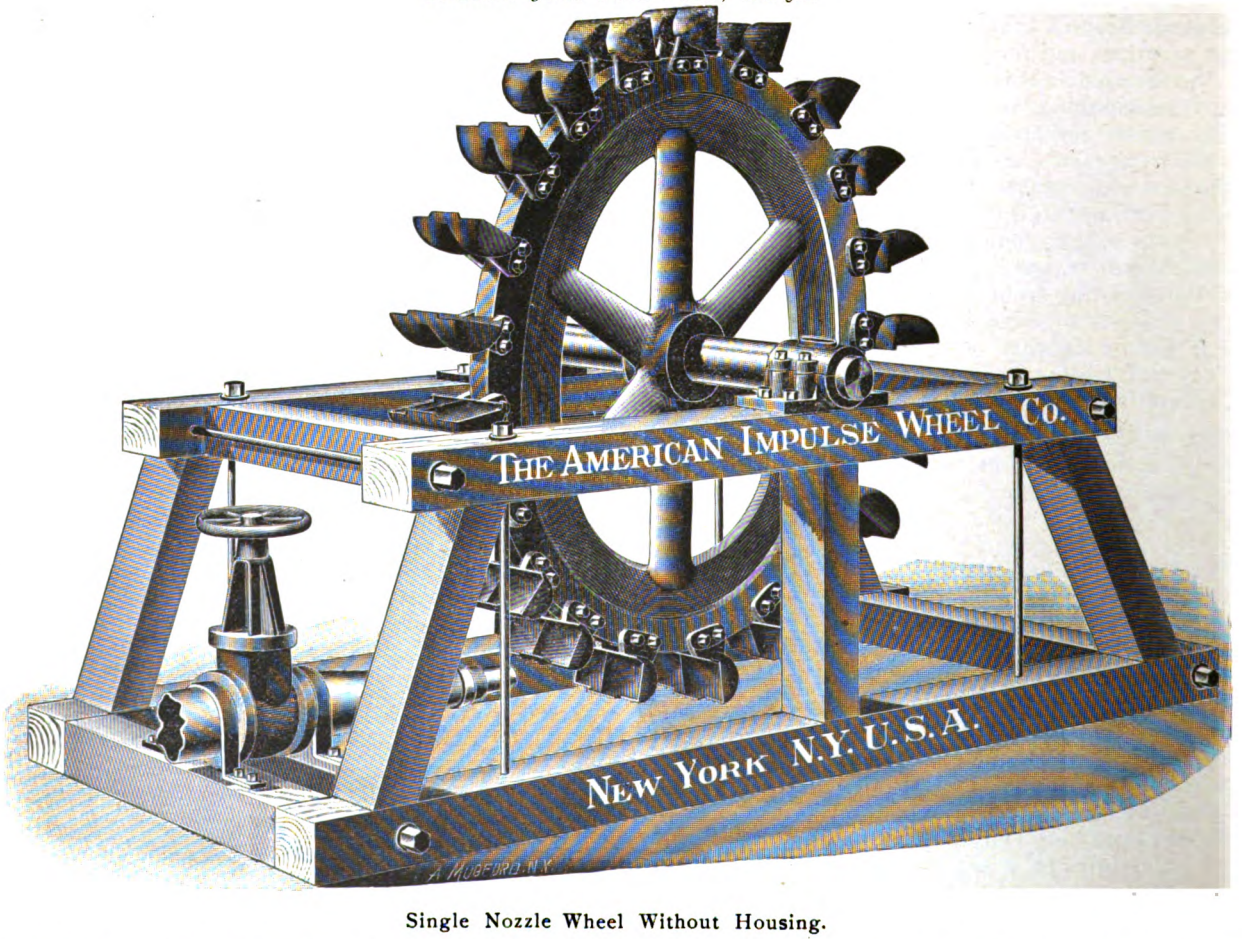
mill of Holland, the water wheel of Switzerland, have exercised a wonderful influence over the commercial life

stimulus can be traced in thousands of cases To the scientific observer power abounds on all sides, in the



Standard 36-in. Twin Wheel, No. 5A.



Single Nozzle Wheel Without Housing.

in those countries. The influence of the water wheel in developing industries lying latent for want of the proper

winds, the tides, and particularly in streams of running water.

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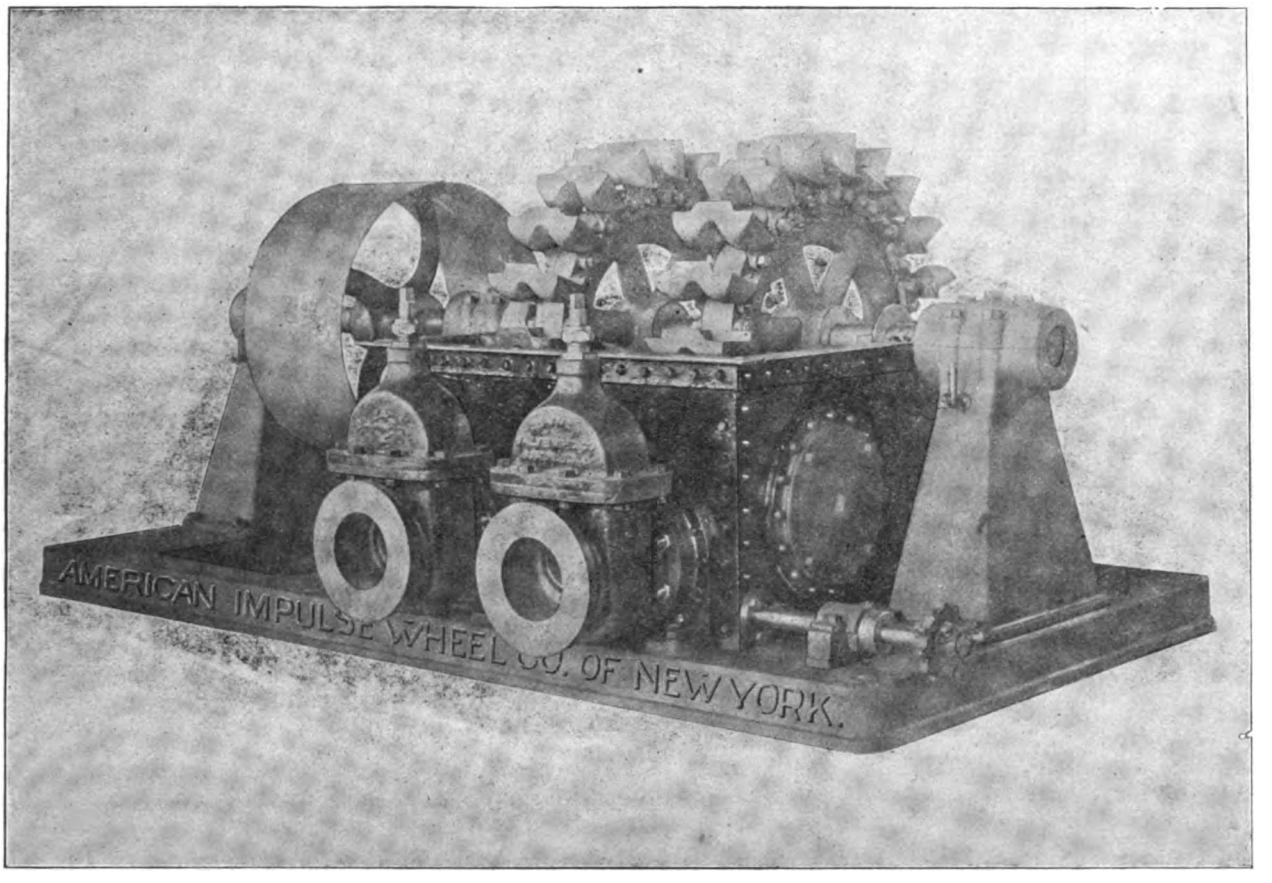
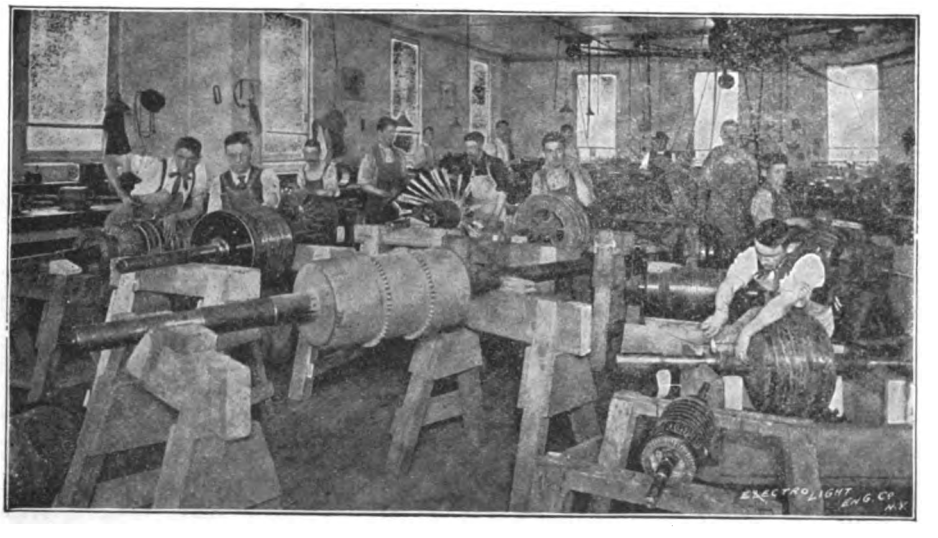
The water wheel industry represents the natural outcome of efforts made to turn this natural force to good purpose; to transform the kinetic energy of a waterfall into another force better adapted to manufacturing purposes than the unbridled and useless power which grinds the rock year after year into impalpable dust. Water wheels must serve their purpose by fulfilling certain conditions. The purchaser of a water wheel must supply to the manufacturer details regarding the head, quantity, power and speed required and length of pipe line. The manufacturers of the American Impulse Wheel, in their new catalogue treating of the water wheels manufactured by them, not only point out these facts for the benefit of the intelligent reader, but carefully define the meaning of head, quantity of water, power and speed, etc.

The American Impulse Wheel Company, of New York City, 120 Liberty street, produce that type of water wheel called the "hurdy-gurdy." The advantages of this wheel are very apparent to the technical mind. In all cases where it is desirous to use water power of great head the "hurdy-gurdy" wheel has proved itself by practical experience the superior of all other types, and consequently has been regarded in the end as the only wheel to be considered under such circumstances. The use of turbines in connection with water power of great head is in some respects a dangerous practice, on account of the rapid deterioration of the turbine due to the water possessing too much projectile energy.

The buckets of the Cazin impulse wheel represent an original departure from those sold on wheels manufac-



Standard 36-in. Twin-Wheel, No. 5A.



Chesley Electric Co., Hoboken, N. J.—Armature Winding Room.

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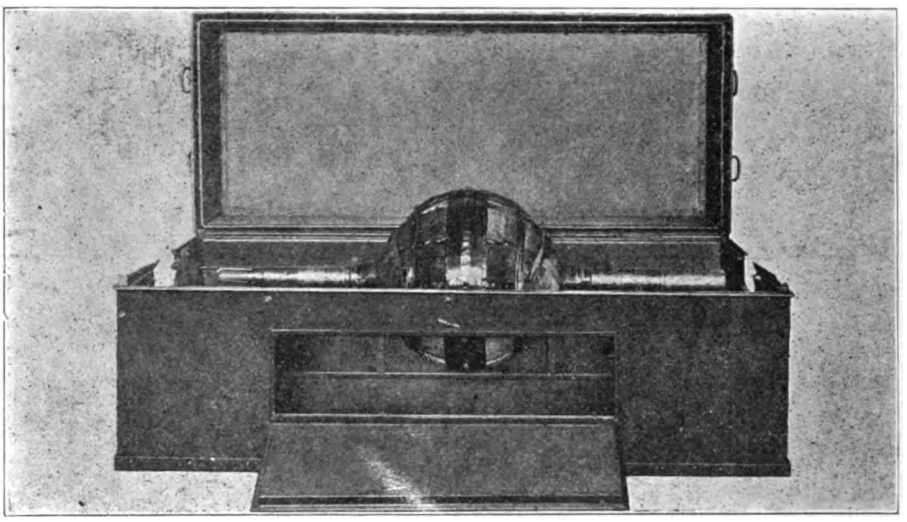
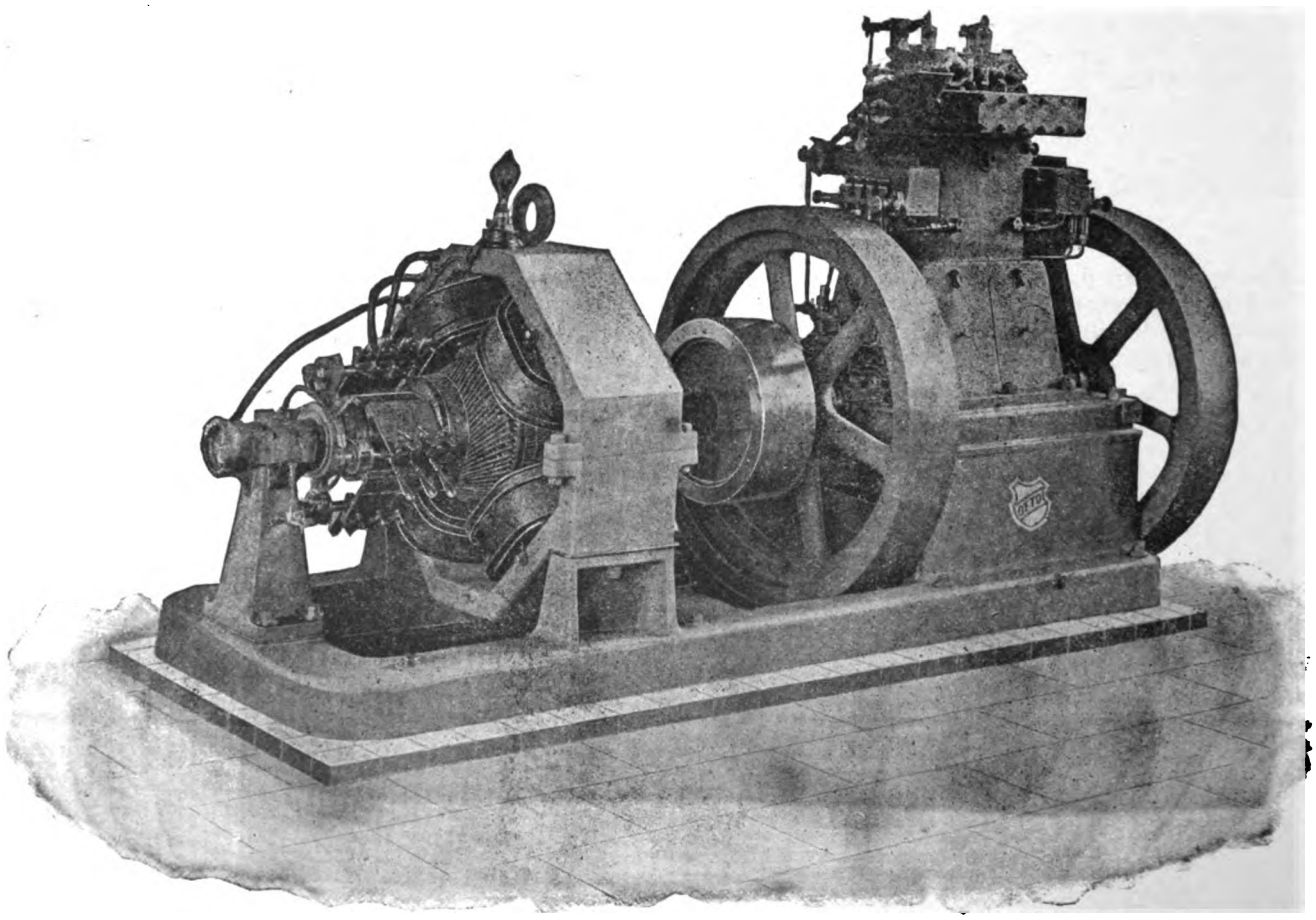
tured by other companies. It might be a point of information for our readers to know that an impinging jet of water does not deliver up its entire energy unless it is received in such a manner that it actually reverses in direction after impact. By the use of projecting knife edges with which the buckets of the Cazin impulse wheel are supplied the stream of water, as it were, is so directed that it practically curves abruptly and reverses. This feature of construction makes this wheel the superior of other water wheels, enabling it to deliver the mechanical energy of the falls at a higher rate of efficiency than any other device of a similar nature.

Many prominent authorities have examined into the design of this wheel and spoken of it in terms of the highest praise. Prof. Philip R. Bjorling calls it the latest and best tangential wheel, and all purchasers of it inevitably come to the same conclusion. Catalogues will be sent to all those communicating with the company at its New York address, 120 Liberty street. Tables are given in this catalogue of the horse power delivered by their different wheels with different heads of water. The regulation of the speed and gate of a water wheel is governed by the mechanism supplied through the American Impulse Wheel Company and called the Lombard water wheel governor, which they recommend highly for this purpose. For electric lighting, to which purpose most water power plants are used, this governor will be found most desirable in connection with the impulse water wheel. The illustrations supplied with this article represent some of the wheels turned out by this company.

The number of installations already made using the American impulse wheel cover a very long list. Proprietors of water still undeveloped should certainly communicate immediately with this concern for advice.



Chesley Electric Co., Hoboken, N. J.—One of the Drying Ovens, showing Armature in Position.



A Model Plant.

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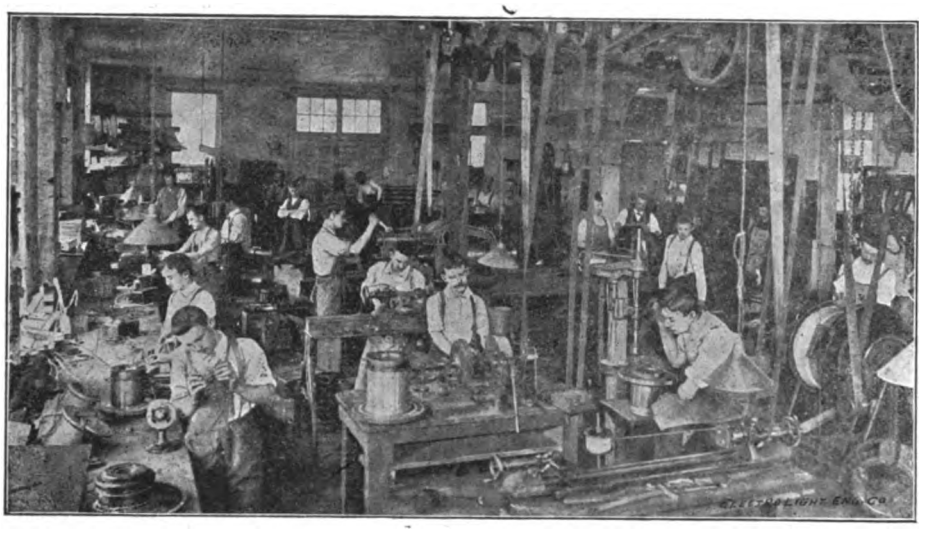
REPAIRS OF ARMATURE, COMMUTATOR AND FIELD.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

The dynamo is composed of three important parts, which must receive careful attention each day or they will be apt to cease operating and destroy the utility of the machine. The armature, commutator and field of a dynamo are the three essential parts which develop peculiarities that sometimes cause the engineer considerable trouble.



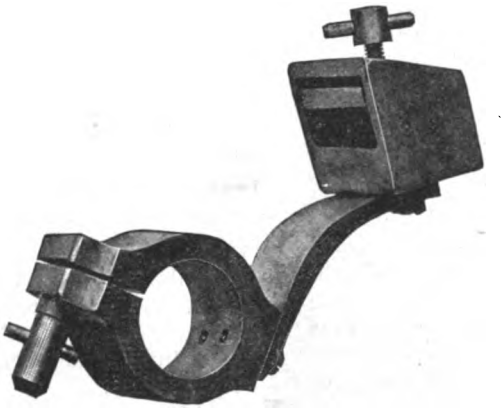
Chesley Electric Co., Hoboken, N. J.—Machine Shop

The armature is subject to grounds and short circuits which may be local and general, serious or of little consequence, depending upon the style of winding.

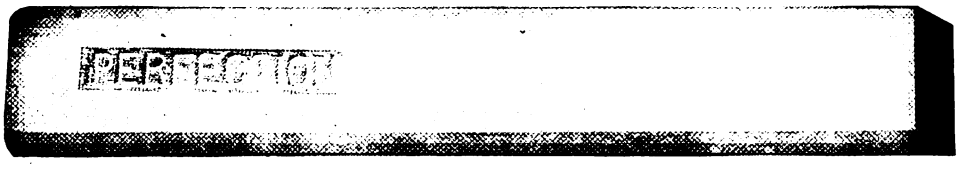
The commutator likewise may be loosely put together, have bad insulation or be slowly ground into a shape like a door-knob, due to the pressure of a grinding brush and a choice collection of injurious sparks.

The field may likewise demonstrate its inability to perform its functions on account of a scorching it may have sustained, or the fact that it is reversed or is otherwise injured.

The repairs of an armature naturally constitute an important department of electrical engineering. Grounds and short circuits make themselves perceptible in ways that can be discovered by testing. A ground, it may be understood, is due to the leakage of current through the insulation, to a great degree, or the touching of the wire against the framework or any metallic part of the machine. A ground may occur in one coil, several coils associated together or apart from each other, or it may be felt throughout the entire armature. If the ground is in a single coil, that coil will have to be removed if its presence interferes with the operation of the machine. A dynamo will run successfully for years, even though



The Perfection Brush Holder (see next page).



The Perfection Brush (see next page).

grounded, without any difficulties whatsoever; but it is in a sense tempting Providence, because a ground on the other side will constitute a short circuit.

There are such things in armatures as insulation grounds due to moisture getting inside, or caused by an alcoholic dampness, due to the fact that the armature has not been well baked. Short circuits, of course, either melt the wire entirely or so burn the insulation that it becomes a charred and blackened mass. If the armature

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is of the Gramme type, a coil can be very easily replaced, but if a drum armature it will be a difficult matter to repair a coil without disturbing the others, unless it be on the outside.

The Eickemeyer Motor Company built a machine the armature of which was wound with detachable coils. This made it a very simple matter to remove a coil or coils that became injured. The only way in which a Siemen's armature can be repaired of the ordinary type is to strip off all the coils until that one is reached which is either burnt, grounded or otherwise affected. By using ventilated winding, such as that adopted by the Schuyler Company in the construction of their arc light dynamos, many of these troubles disappear, and the overheating of any given coil does not exert any evil influence upon its neighbors by transmitting heat to them and injuring them likewise. The repair of a coil is carried on in the same way as if it were to be rewound. A test is first made for the ground, if it occurred at any specific point. That portion is taped and the coil completed. The two ends of the coil are then tested for continuity of the metal and then tested for grounds; one end of the coil with the armature core and then the other end likewise. The tinning of these terminals that set into the commutator segments is effected, if possible, without the aid of acids, although if great care is taken to prevent the acid from saturating the insulation it may be used without danger.

Toothed armatures sometimes heat very severely; it is worth while mentioning here that this heat is not always due to the winding, because an armature of this description may be tested by the fingers and it will be discovered that the iron is hotter than the conductors. This is due to a poor design of the teeth of the armature, and the engineer's only remedy, which we would not advise him to attempt, is to bore out the fields a little larger.

The commutator, as we have mentioned, may have a grinding brush. It may spark; it may be filled with poor mica, and the mica, if good, may be oil-soaked. It is a difficult matter to repair a commutator except to turn it down. The sparking may be due to a bad position of the brushes, which the engineer can attempt to remedy. The grounded or oil-soaked mica can have its evil effects removed by carefully baking the commutator, thus drying up the oil and removing that as a source of trouble. But if the mica is causing a ground that cannot be attributed to the oil, the segments will have to be tested in pairs until the ground has been located and the mica causing the trouble removed. Commutators must never be cleaned with emery paper, but fine sandpaper should be used.

If a commutator becomes very hot while running, it is due to the fact that the segments are too small for the current passing. This may occur at the beginning or after the machine has been in use for many years; the commutator in the meantime becoming thinner and thinner at every turning. The only remedy for this is a new commutator. Frequently the use of carbon brushes of insufficient capacity will cause a leakage of the commutator by generating heat within themselves due to the current and friction and transmitting it to the commutator segment. The field is very easily repaired. It may be burnt out, reversed, lack ventilation and therefore heat, have broken connections or become affected by moisture, in addition to the short circuits and grounds that generally affect windings, whether of armatures or fields.

(To be continued.)

THE PERFECTION BRUSH AND BRUSH-HOLDER.

Each of the various manufacturers of dynamos has probably met with the severest trials in selecting a brush which, in his opinion, possesses qualities that recommend it for practical work. It took a great many years for the technical world to be fully awake to the urgent necessity of supplying dynamo tenders with brushes that were durable and elastic. The history of brush manufacture dates back to rather early times, yet no radical change was instituted in their construction until deteriorating commutators and short-lived brushes made this improvement most necessary.

The Perfection bronze brush manufactured by the Perfection Supply Company, 621 Broadway, New York city, does not abrade the commutator, requires little or no attention and does not excite sparking. It is perfectly flexible and possesses none of those undesirable scratchy qualities which make other brushes notorious, but not famous. This finely constructed brush is made of phosphor-bronze wire gauze, so tempered that it is perfectly fitted for the work it performs. It is made in sizes that range from one-half an inch in width to three, and one-half an inch in thickness to three-sixteenths, being either seven or eight inches long. Special orders are attended to as readily as though goods were in stock. The New York "Herald," Central R. R. of New Jersey, Edison Illuminating Company, Hotel Waldorf, etc., patronize the Perfection Supply Company as well as thousands of others.

The Perfection brush holder, illustrated in these columns, is manufactured by the same concern and represents the strongest and simplest brush holder in the market. The spring never becomes annealed. The holder itself has nothing about it to get out of order. It will last through the seven ages of man and be still as good as new at the end of that time. Its extreme simplicity, ease with which it is set and cheapness, make it highly desirable to the engineering profession. It enables the brush to be used up almost entirely, leaving the shortest kind of a stump behind. The economical engineer will find in it a bonanza, the profession in general a much needed article.

NEW ELECTRICAL INCORPORATIONS AND BUSINESS CHANGES.

Sebastapol, Cal.—G. W. Swain is interested in the establishment of an electric light plant.

Minneapolis, Minn.—The Northwestern Telephone Exchange Co. will increase capital stock of the company to $4,000,000.

Columbus, Ohio.—The Dayton and Germantown Traction Co. has been incorporated by Fred Shoop, Isaac J. Bassett, Noah Coler, T. B. Meredith and Theo. C. Lindsey; to build and operate an electric railway. Capital stock, $10,000.

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PORTABLE DIRECT READING

VOLTMETERS AND WATTMETERS

For Alternating and Direct Current Circuits.

The only standard portable instrument of the type deserving this name.

Write for Circulars and Price Lists 8 and 9.

WESTON ELECTRICAL INSTRUMENT CO.

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FROM $30 A YEAR.

IN THE BRONX

FROM $40 A YEAR

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An Extension Station

saves time and trouble, insures privacy, adds to the convenience and flexibility of the telephone service. The rate for an Extension Station, to Message Rate Subscribers, is now $1.00 a month, with installation charge.

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The private Branch Exchange is the proper cure. Many lines are "busy" from 50 to 200 times a day. This is tantamount to turning away business every working day.

A properly designed Private Branch Exchange is never busy.

Stations $1.00 a month and cost of installation; messages, lines and other equipment at correspondingly low rates.

Public Pay-Station Rates.

TEN CENTS
For a message in Manhattan.

TEN CENTS
For a message in The Bronx.

TWENTY CENTS
For a message passing between Manhattan and The Bronx.

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No increase has been made to the tolls for out-of-town telephone messages on account of the War Revenue Tax.

The Telephone System of Manhattan Island is the Largest Metallic-Circuit System in the World.

Considering the quality of the service furnished, the refinement of the facilities supplied and the cost of maintaining the plant and organization, telephone charges are nowhere in the world more reasonable.

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NEW X-RAY TUBE

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No more Troubles from High Vacuum Tubes.

SIMPLE AND EFFICIENT.

Keeps Vacuum Adjusted Automatically. Can not run too high in Vacuum for Operation. Life practically unlimited.

Roentgen-Ray Exciting Apparatus: Thomson Inductoriums, Thomson Roentgen-Ray Transformer Sets, Fluoroscopes, etc. Catalogue No. 9050.

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HARRISON, NEW JERSEY.

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TURBINE WHEELS, for Heads of 3 to 220 feet.
CASCADE WHEELS, for Heads of 50 to 2000 feet.
Suited to all Water Power Purposes.
Pamphlet of either Wheel sent free. State your Head.
JAMES LEFFEL & CO. Springfield, Ohio, U.S.A.

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PRICE,
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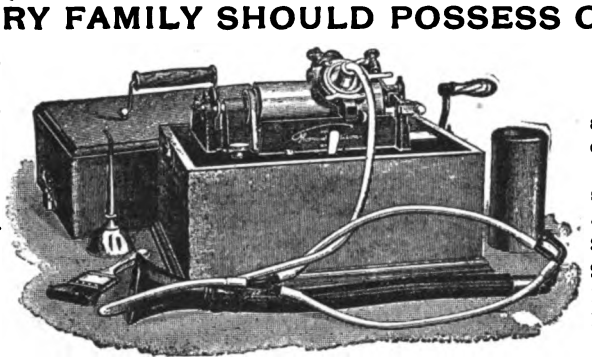

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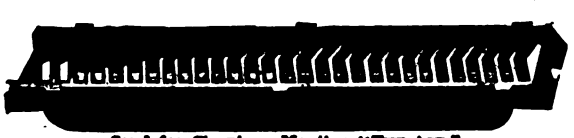

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WILL PRODUCE A SHELL IN 30 MINUTES.

Manufactured by the

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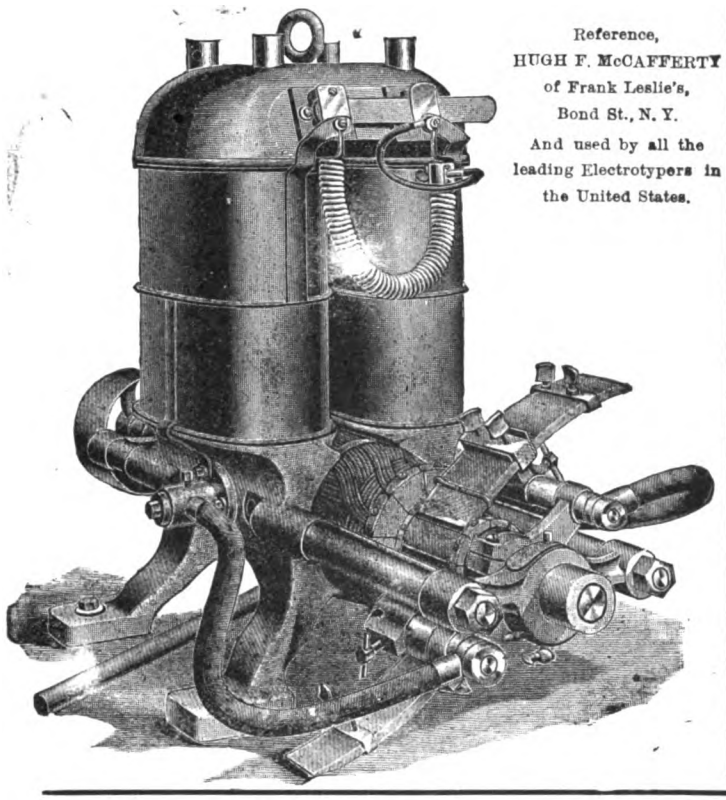

Reference,
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of Frank Leslie's,
Bond St., N. Y.
And used by all the leading Electrotypers in the United States.

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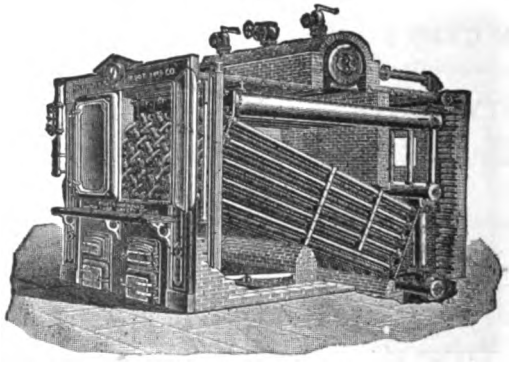

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Examine these Points in the Improved Root Water-Tube Boiler.
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ABENDROTH & ROOT MFG. CO., 28 CLIFF ST., NEW YORK CITY.

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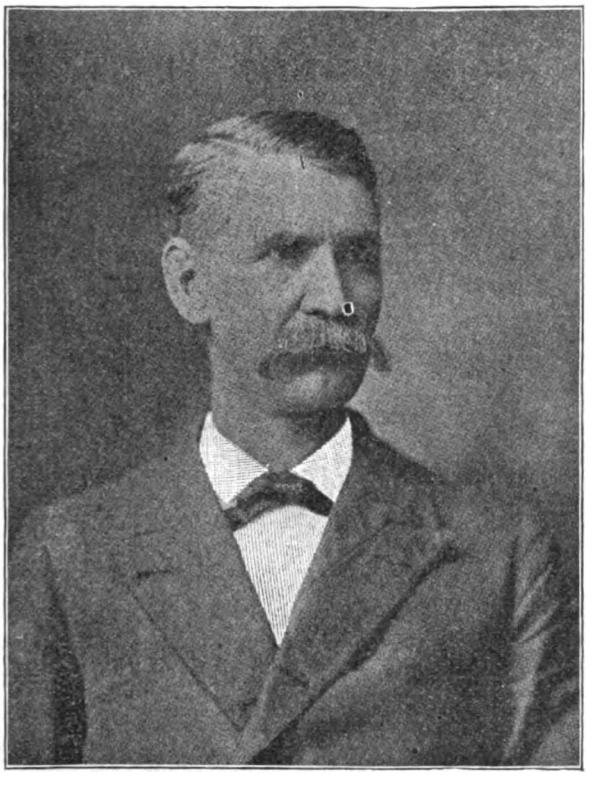
The Electrical Age.

VOL. XXII—No. 10 NEW YORK, SEPTEMBER 3, 1898 WHOLE No. 590



Albion E. Lang, President A. S. R. A., 1897-98.

Robert McCulloch, President A. S. R. A., 1896 97.

ANNUAL CONVENTION OF THE AMERICAN STREET-RAILWAY ASSOCIATION.

Boston will be full of street-railway men this week. The seventeenth regular annual meeting of the American Street-Railway Association will be held there during the 6th, 7th, 8th and 9th of September. The city of Boston is a well chosen spot for a convention of this kind, as it inherits traditions that make it unique among American cities and to Americans and is also the heart of great electrical industries, particularly electric street railways.

The great Boston tunnel has been mentioned repeatedly in the electro-technical journals, and the great power-houses have received constant mention. It is therefore likely that the Boston convention will be remembered by delegates as a circumstance of great interest possessing features of attraction that will always make it a pleasant memory.

It may be interesting to our readers and to the present members of the association to know that the first meeting of the American Street Railway Association was held at Young's Hotel, December 12, 1882, more than fifteen years ago. The birthplace of an individual or an organization is alwaysinteresting in after years, when times and events have favored the growth of either.

The association was originally founded by H. H. Littell, Walter A. Jones, Thomas Lowry, Henry M Watson and J. E. Rugg. Mr. D. F. Longstreet is credited with the idea or at least the suggestion that led to the organization of this association. A letter was prepared and sent to all the street-railway companies in the United States and Canada, the purpose of which was well stated. All traction companies were asked to support and assist in the formation of an association for the "promotion and advancement of knowledge, scientific and practical in all matters relating to the construction, equipment and management of street railways; the establishment and maintenance of a spirit of fraternity among members of the association by social intercourse and friendly exchange of information and ideas to the end that the best service may be obtained at the least possible cost." Thus it was that life was first given through the earnest efforts of these men to this new and now powerful organization.

The last convention took place at Niagara Falls, and before that meetings have occurred in all the large cities of the Union, as far north as Montreal, as far south as Atlanta. Since the first meetings have taken place the face of this country in municipal centres has been transformed. The horse-car has almost disappeared; the dream of Stephenson, the great car-builder, has been realized, and in place of the curious and antiquated vehicles of not so long ago, we find well-equipped cars driven by electricity and provided with every convenience that safety, common sense and a spirit of æstheticism can recommend. The labors of early electricians have become historic. Menlo Park, with its little strip of track, should be well remembered by those that now live on the fruit of this great industry. Since horse-car traction has given way to the inroads of electricity a study of tracks and motors, cars, stations and all pertaining thereto has become imperative, and as the association originally met to discuss the ways and means of saving horse-flesh and keeping their roads in good order, so now do they meet to consider the best means of saving current, and again, as of old, to discover remedies for faulty tracks and inefficient power-houses.

A list of papers to be read at the Boston convention by experienced electrical engineers and business men is as follows:

1. "Maintenance and Equipment of Electric Cars for

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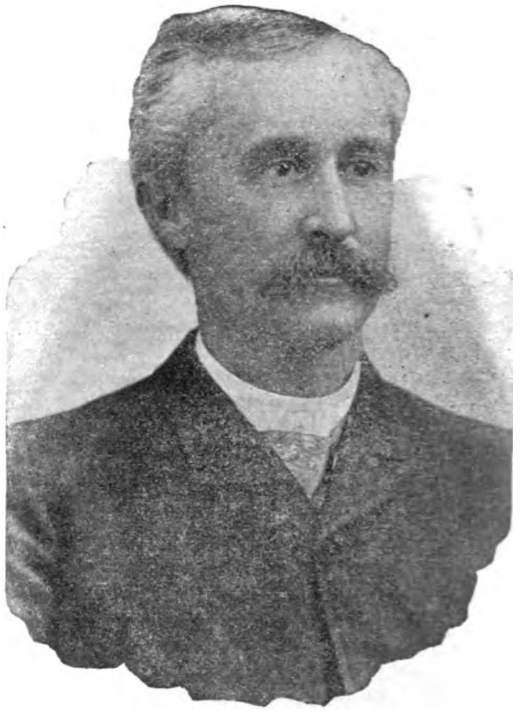
T. C. Pennington, Sec'y 1896-7.

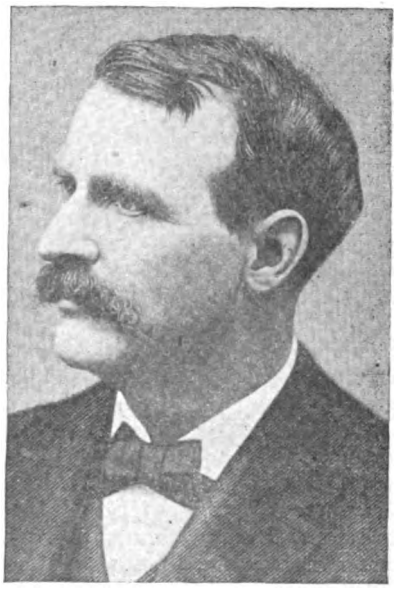
H. M. Watson.

G. B. Kerper.

H. M. Littell.



Joel Hart.



H. C. Payne.

C. B. Holmes.

D. F. Longstreet.

PAST PRESIDENTS,
A. S. R. A.

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Railways," by M. S. Hopkins, Electrician Columbus Street Railway Company, Columbus, Ohio.

3. "The Carrying of United States Mail Matter on Street Railways," by W. S. Dimmock, General Superintendent Omaha & Council Bluffs Railway and Bridge Company, Council Bluffs, Ia.

W. H. Hazzard, 1883-1884.
Thomas Lowry, 1889-1890.
T. W. Ackley, 1886-1887.
John G. Holmes, 1891-1892.
H. H. Littell, 1882-1883.
J. S. Walsh, 1885-1886.
C. A. Richards, 1884-1885.

2. "To What Extent Should Railway Companies Engage in the Amusement Business?" by W. H. Holmes, General Manager Metropolitan Street Railway Company, Kansas City, Mo.

4. "The Comparative Earnings and Economy of Operation Between Single and Double Truck Cars for City

Use," by Richard McCulloch, Electrical Engineer, Cass Avenue and Citizens' Railway Companies, St. Louis, Mo.

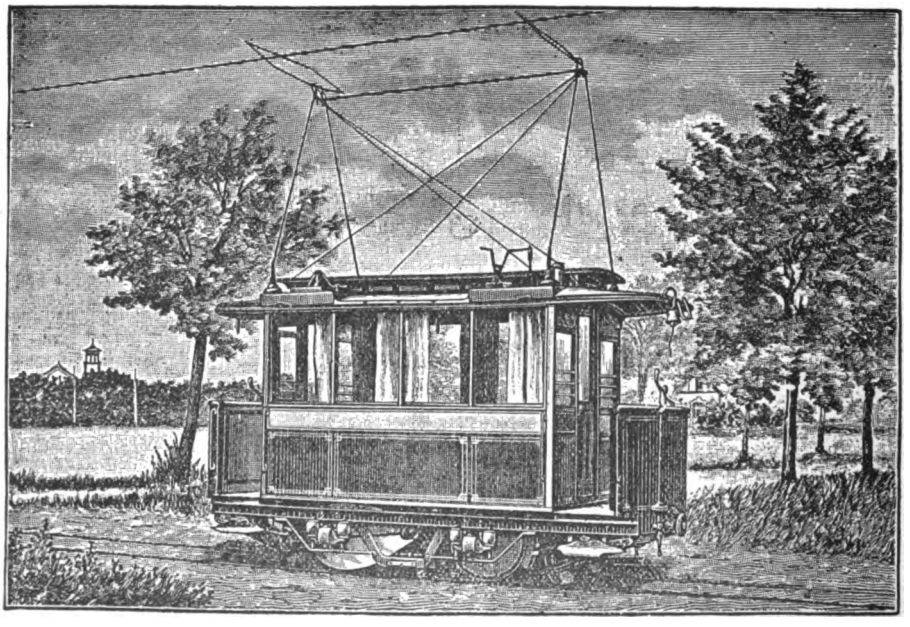
5. "Inspection and Testing of Motors and Car Equipment by Street Railway Companies," by Frederick B. Perkins, Electrical Engineer Toledo Traction Company, Toledo, O.

6. "Cost of Electric Power for Street Railways at Switchboard; both Steam and Water," by R. W. Conant, Electrical Engineer Boston Elevated Railway Company, Boston, Mass."

Some of our very largest manufacturers of cars, locomotives, motors, trucks, wheels, etc., will exhibit in the hall at which the convention will be held, namely, the Massachusetts Charitable Mechanics' Associaton Hall. This hall is situated in the immediate vicinity of the largest hotels of Boston and is quite near the centre leading to all points of interest.

John Stephenson.

The past executives of the American Street Railway Association, through their individual efforts, have added so largely to the success the Association now enjoys that we thought our readers would be pleased to see them face to face. The gentleman still in office is Mr. Albion E. Lang, president of the Toledo Consolidated Electric Company, of Toledo, O., a man of considerable executive ability.



The Trolley Car Before the Days of Its Popularity.

The convention will be opened up by many prominent

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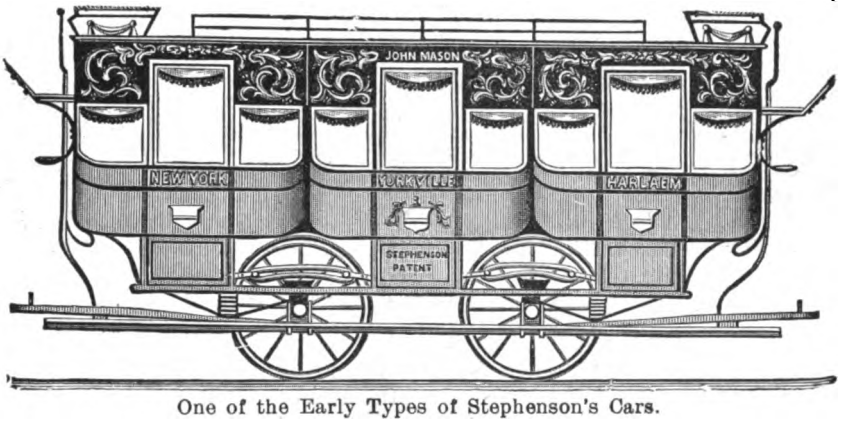
characters of Boston and will extend from Tuesday until Friday of next week. At the last meeting the following officers were elected: Albion E. Lang, of Toledo, O., president; first vice-president, W. Caryl Ely, of Niagara Falls, N. Y.; second vice-president, J. A. Riggs, of Reading, Pa.; third vice-president, E. G. Connett, of Nashville, Tenn.; secretary and treasurer, T. C. Penington, of Chicago. The executive committee is composed of the following gentlemen: Robert McCulloch, of St. Louis; C. D. Weyman, of New Orleans; H. C. Moore, Trenton, N. J.; John Roach, Chicago; R. S. Goff, Fall River, Mass.

The customary nominations and elections will be in order at the convention in accordance with the prescribed rules.



One of the Early Types of Stephenson's Cars.

RAILWAY NOTES.

The Safety of Railway Travel.

Last year on American railways one passenger was killed in accidents out of every 2,827,474 passengers carried. That is to say that you can take a train 2,827,474 times before, on the law of averages, your turn comes to be killed. You will have to travel 72,093,963 miles on the cars before that turn comes, and 4,541,945 miles before you are injured. If you travel 20 miles every day for 300 days in the year, you can keep on at it for 758 years before your turn comes to be hurt. If there had been railways when our Saviour was born and you had begun to travel on the first day of the year A. D. 1, and had travelled 100 miles in every day of every month of every year since then, you would still have (in this year 1898) nearly 3,000,000 miles yet to travel before your turn came to be killed.

Taxes Paid by Railways.

The preliminary report of the Interstate Commerce Commission for 1897 shows that last year the railways of the country paid $40,979,933 in taxes. All companies had not reported, but compared with the preceding year the report shows that on about 2,000 miles of road less in 1897 than in 1896 the railways paid about $3,000,000 more of taxes. The total dividends paid during the year were $57,290,579. Out of every 97 cents earned by the railways above expenses, therefore, 57 cents was profit and 40 cents went in taxes. In the central southwestern states (Kansas, Missouri, Arkansas, Colorado, Oklahoma and Indian Territory) the taxes exceeded the dividends by nearly $3,000,000. In Texas taxes exceeded dividends by over one million. In New England and the northeastern states dividends largely exceeded the taxes. The report shows that in the densely populated states the railways could pay more taxes than they do, but that in the less populous states of the middle and west the taxes are already in excess of the profits from the business.

Profits of Railways.

The report of the Interstate Commerce Commission shows that last year the railways of the United States carried over 13,000,000,000 passengers 1 mile. They also carried 95,000,000,000 tons of freight 1 mile. The total amount paid in dividends on stock was $87,603,371—call it $88,000,000. Of the total earnings of the railways about 70 per cent. came from the freight service and 30 per cent. from passenger service. Let us assume, then, that of the $88,000,000 paid in dividends, 70 per cent., or $61,600,000, was profit on freight service and $26,400,000 was profit on passenger service. Let us drop fractions and call it $62,000,000 from freight and $26,000,000 from passengers. By dividing the passenger profit into the number of passengers carried (13,000,000,000) we find that the railways had to carry a passenger 500 miles in order to earn one dollar of profit—or 5 miles to earn one cent. Their average profit, therefore, was less than two-tenths of one cent for carrying a passenger (and his baggage) 1 mile.

By dividing the freight profit into the freight mileage (95,000,000,000) we find that the railways had to carry one ton of freight 1,530 miles in order to earn one dollar, or over 15 miles to earn one cent. The average profit, therefore, was less than one-fifteenth of a cent for carrying a ton of freight (besides loading and unloading it) 1 mile.

JOHN HOPKINSON'S DEATH IN SWITZERLAND.

A cable from London announces the accidental death in Switzerland of John Hopkinson, "the celebrated English electrical engineer," and that of his son and two daughters. From the meagre information at hand, we learn that the party started out on August 27 from Arolla, in the Canton of Valais, to ascend the Dent Vesivi without a guide. As they did not return at night, a searching party was organized, with the result that all four bodies were found at the foot of a precipice over which they had fallen.

Montreal, Que.—An important contract has been made between the Dominion Cotton Co. and the Royal Electric Co. The former are to install electricity in their works as motive power. The contract calls for 1500 horse power from the Chambly works, with option of increasing it to 3000; the contract is to run twenty years.

Kingston, Ont.—The Electrical Construction Co. of London, Ont., are in need of increased accommodation, and an effort is being made to have the company install its works in this city.

Listowel, Ont.—The by-law to raise $19,500 for water works and electric light purposes was defeated by the ratepayers.

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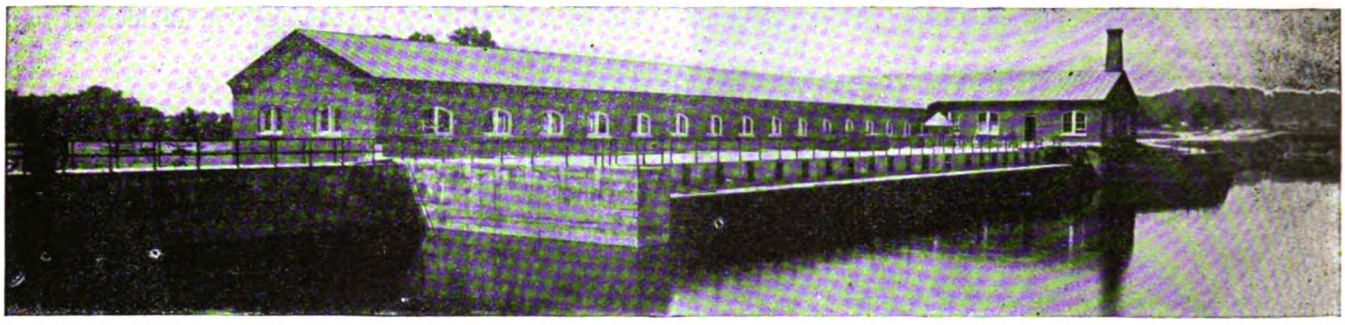
MECHANICVILLE.

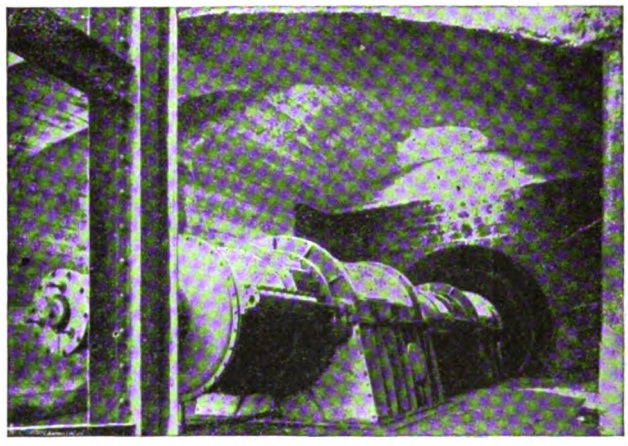
Introduction.

The development of the power of St. Anthony's Falls on the Mississippi at Minneapolis, Minn., is followed closely by the utilization of the power of the upper waters of the Hudson River at Mechanicville, N. Y., where an undertaking of no less magnitude has within the past few days been completed. Five to seven thousand horse power is available at the power house, and the use of high tension current permits of its distribution over a wide territory.

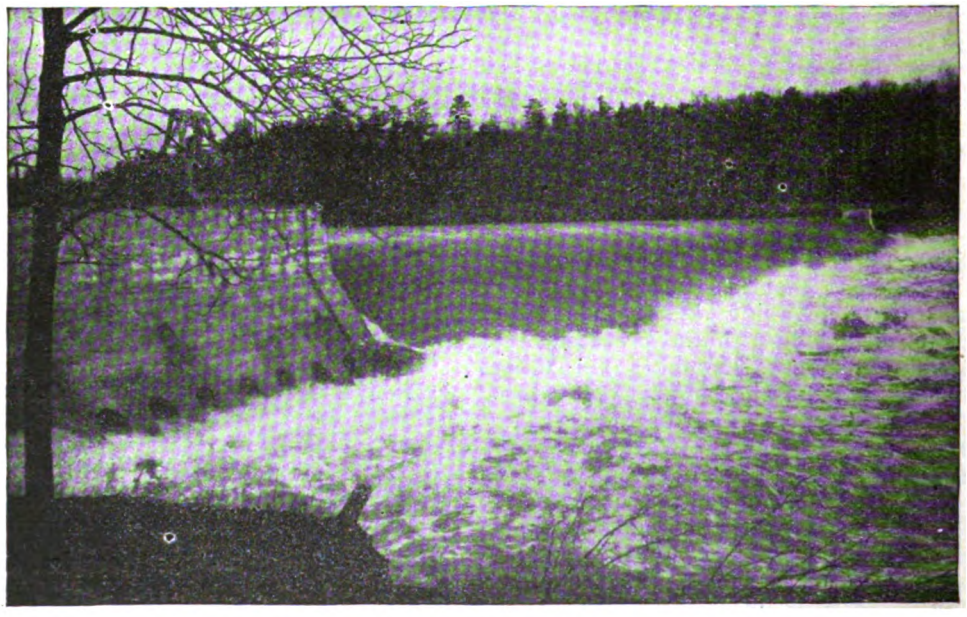


Power House from Up-stream Side.

As in the Mississippi, the waters of the Hudson above the present point of development have been to some extent employed by factories using low-head turbines directly driving their machinery, but not until the undertaking just concluded was decided upon had any very serious effort been made to take advantage of the great amount of power which has run to waste for ages down the stream of the main waterway of the Empire State.



A Main Wheel Chamber, Mechanicville, N. Y.



The Main Dam and Waste Gates.

Early in 1897 the attention of Mr. R. N. King, president of the Stillwell-Bierce & Smith-Vaile Co., of Dayton, O., was drawn to this water power. His long experi-

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ENGINEERS FOR FIRE PROTECTION.

One of the demands of the municipality is that all new buildings and old shall be protected against fire and that any installations contained therein shall be free from any immediate possibility of fire. Modern buildings of large size are equipped with steam and electric light machinery, fire from which could arise at any moment unless precautions are taken of a most definite character to prevent the same. In consequence of this a department of engineering new in its way has been suggested by Mr. H. L. Phillips, which will consider ways and means of protecting property from fire in any form due to the arrangement of machinery within. This is a most interesting field of investigation and worthy of serious consideration by not only professional men or engineers, but the public at large, to whom the loss by fire annually exceeds one hundred millions of dollars.

The electrician should feel particularly impressed with the necessity of putting in an installation safe in every respect and amply protected with the proper fuses and adjustment of wires from fire risk. Whenever there is a mystery attached to a fire, allusion is made to the electric light wires in the building; but in answer to this we may say that under no circumstances is a building under less risk from fire than when wired by a conscientious contractor in a manner that meets with all the requirements of the city fire underwriters.

Attention need not be especially directed towards the purely electrical portion of the work, but to the steam-pipe system, boiler, position of coal supply, etc. The general arrangement of these things counts for a great deal in the eyes of insurance companies when application for insurance is made by a large concern. A casual examination of the interior of a building does not always disclose the immediate chances of fire present there. Such an examination should be backed by considerable experience and an extensive knowledge of the effects of too close a juxtaposition to materials normally safe, but which under the influence of a constant heat, vibration, etc., might change in character and give rise to a conflagration.

As the hygienic demands of city residents became more pronounced and it was necessary to discover and prevent the mischief arising from poor sanitary accommodations, a new field of engineering developed and received recognition in many of the largest universities under the name of "Sanitary Engineering." In the same sense the necessity for a department of fire-protection engineering in some of the universities is obvious. A degree of this kind would confer upon its holder an immense amount of responsibility in the inspection of buildings and demand from him an intimate knowledge of many of the details of construction in electrical and mechanical engineering.

Mr. Phillips makes mention of the fact that "the electrical engineer must give consideration to the element of fire in arranging the lighting or power apparatus, and special rules have already been formulated regarding the installation of such an equipment. All matters of this sort, strictly speaking, come within the scope of fire-protection engineering and should be taken up in connection with it. And here we have another field for men trained in the new science."

THE ORGANIC ELECTRIC BATTERY.

Some of the reasons why Nature produces abnormal organic types are so completely hidden that we are forced to resign ourselves to the fact and frame a hypothesis as to their primal cause. A large variety of fish possess an electric organ composed of a series of cells enabling them to affect a discharge of nearly eigh hundred volts pressure. The origin of this organ, the history of its development and the means by which the fish is enabled to accumulate electrical energy, are at present beyond our powers of exact comprehension. The batteries possessed by these fishes are apparently uninsulated from the body of the fish itself, and more curious still is the fact that the fish is exposed to the shock of each discharge as well as the victim receiving it. Mention is made by Faraday of the extent of this discharge of an electric fish, the gymnotus, by his comparing it to the discharge of fifteen Leyden jars connected in series. The fact that the fish itself is neither stunned nor shocked by its own discharge, has been explained by considering its immunity due to inherited familiarity with the same for countless ages. This species has used functions as described, and in the course of many centuries become insensible to the influence of high potential currents.

Mr. W. W. Knight, in an article on electric fishes, in the "Yale Scientific Monthly," mentions an experiment in which a spark coil was applied to an electric fish. The shock of the coil barely affected it, whereas it killed pike and chub immediately.

It is very likely that in some mysterious way a transformation of nerve energy occurs in the fish whereby it is able to give rise to electric discharges, or the nutrition of the cells of the battery from which discharges proceed calls heavily upon the strength of the fish in the same manner that continued thought affects the strength of a brain-worker. As these discharges of electricity take place at the will of the fish, there is certainly some relation existing between the battery and the principal nerve ganglion. It would be interesting to discover whether electricity is produced from a foreign secretion differing from those usually discovered in marine animals, or whether each tremendous discharge is merely due to a transformation of nervous force into electrical energy.

Raleigh, N. C.—The Raleigh Electric Co. has ordered new machinery to be placed in its electric power plant.

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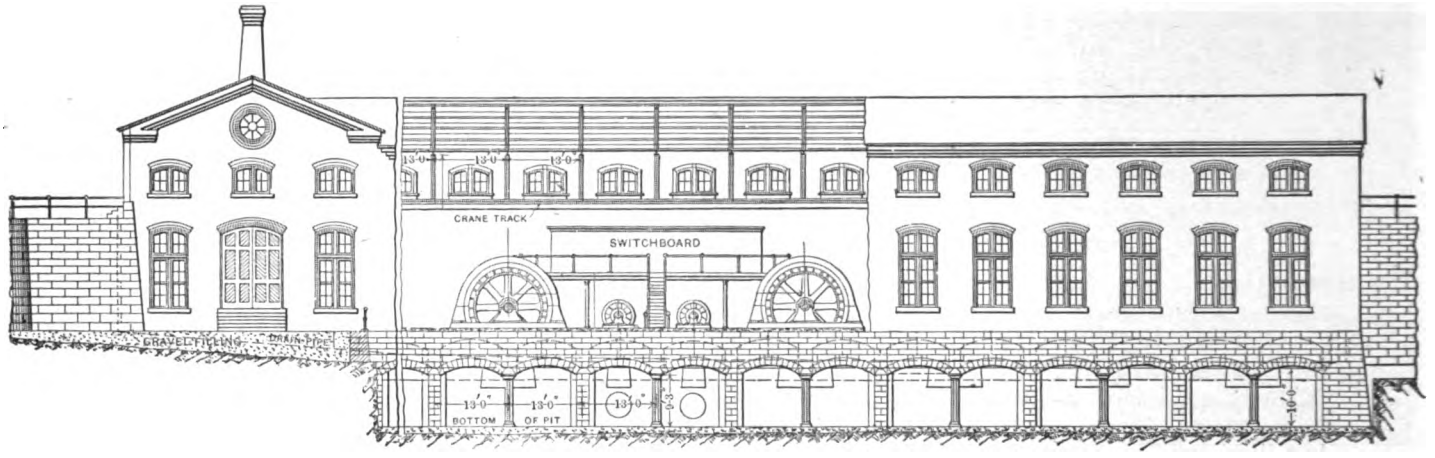
ence with water powers and their development led him speedily to recognize the possibilities which here lay ready to hand. The site is only two miles from Mechanicville, eleven miles from Troy, and eighteen miles from Albany, in each of which towns large quantities of power would without doubt find a market. But, most important of all, it lay only seventeen miles from Schenectady, where, covering not less than 130 acres of ground, the largest electrical works in the world are operated from an extensive steam plant with which the electrical power from the Mechanicville cataract could readily compete.

After consultation with the chief engineers of the General Electric Company, in which the necessary assurances were given, Mr. King formed the Hudson River Power Transmission Co.

The hydraulic engineering features of the development were carried out in their entirety by Mr. A. C. Rice, chief engineer of the Stillwell-Bierce & Smith-Vaile Co., and it may be said that in the complete work as it stands today little or no departure from the plans laid down by Mr. Rice has been made. As the General Electric Co. was to purchase the largest amount of power, its advice as to the electrical equipment was naturally closely followed. The result brought about by the harmonious co-operation of both hydraulic and electrical engineers is a power transmission plant in every respect strictly representative of the most modern hydraulic and electrical practice.

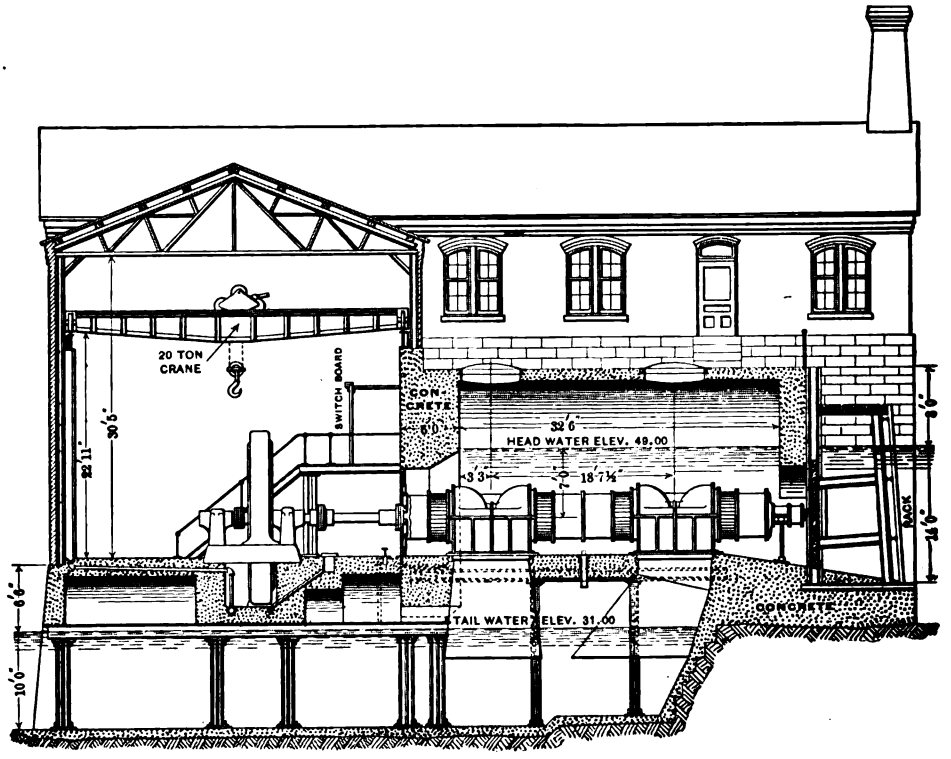
General Location.

At the point chosen for the hydraulic development the physical positions make the location an ideal place for a dam and power house. The banks and bottom of the river are of rock, as is Bluff Island, which divides the Hudson into two channels, and here during the greater part of the year is water sufficient to produce from 7,000 to 10,000 H. P.



SIDE ELEVATION LOOKING UP STREAM.

Side Elevation of Power House, Mechonicville, N. Y., Looking Up-stream.



Section Through Wheel Chambers, Mechanicville, N. Y.

The island is about one-third of the distance across the river from the western bank, the combined width of the two channels being about 1,200 feet. The western channel is used for the head and tail races.

In order to make the excavations for the power house and the main dams, heavy coffer dams were built across both streams. The work would have been completed well within the time at first specified had not an extraordinary freshet swept away part of the coffer dam, necessitating long delay before work could be resumed. The rock and shale resulting from the excavations proved unsuitable for incorporation into the concrete for the dam and foun-

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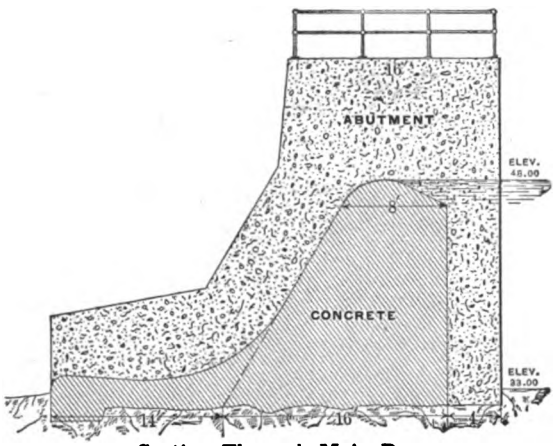
dations, and the broken rock used was brought over a special track from the neighborhood of Schenectady.

Dams.

The power house starts from and extends out into the river about 215 feet, and is connected with Bluff Island by a concrete dam, 26 feet above the bed of the river, 10 feet wide on top and 18 feet wide at the base. The up-stream face is vertical and the down-stream face sloping. The top of this dam is at an elevation that the water will never reach; thus, no provision is made to take care of falling water on the down-stream side, but the dam is provided with four arched waste gates, 4 feet wide and 6 feet 9 inches high, operated in the same manner as those in the main dam.

The Power House.

The power house lies between the west bank and the short concrete dam, nearly filling the space between the island and the west bank of the river. It is practically a continuation of the dam, and, like the main dam, is of concrete, with the exception of the upper walls. Its construction is of the most substantial character; the foundations are carried down to the bedrock, and the house is carried on heavy steel box-web girders resting upon steel I-beam columns. The latter are imbedded in concrete walls carrying arches, which form the floor of the generator room and the floor on which the wheel flumes rest. The walls form a separate and distinct tail race 22 feet wide for each set of turbines, from which the water may be shut out at will.



Section Through Main Dam.

The main dam is on the eastern side of the island. It is built of concrete, as is indeed the entire construction, with the exception of the upper walls of the power house. The up-stream face is vertical; the down-stream face is curved and provided with a horizontal apron 14 feet wide, which throws the falling water off horizontally, and thus effectually prevents wash or scour of the top of the dam. The dam is 16 feet high above the river bed, 8 feet thick immediately below the crest, 16 feet thick through the base, and 30 feet thick through base and apron. The dam is set between massive abutments anchored to the rock sides of the river bank and island. The eastern abutment is 20 feet long, 26 feet high above the river bottom, 16 feet thick at the top and 34 feet wide at the base. The western abutment is 100 feet long, the other dimensions being similar to those of the eastern abutment. The length of the spillway between abutments is 800 feet, In the western abutment are twelve arched waste gates of ample proportions. Each gate is 4 feet wide and 6 feet high, and is opened and closed by a heavy iron hoist operated by rack and pinion. The eastern dam is practically a solid rock wall capable of safely resisting any flood. It was severely tested in the spring of 1898, when a flood of extraordinary proportion came against it, yet, notwithstanding the fact that the dam was green, the flood in no manner injured it. To prevent any floating rubbish, ice or logs reaching the rocks or choking the waste gates, a floating wooden boom stretches from the western end of the spillway diagonally for a distance of 400 feet to the edge of the normal river bank, and then for a distance of 1,000 feet to the main embankment of the Mechanicville highway. It is anchored by a line of stone-filled cribs.

Between the west end of the power house and the Mechanicville highway a broad roadway has been built of earth and slate rock.

To avoid any possibility of water finding its way through the embankment in case of very high water a concrete core was put in the centre, starting at the solid rock and finishing two feet below the surface of the road. The embankment forming the roadway is 40 feet wide on the top, 124 feet at the base, and 18 feet high at the deepest point.

The house is divided into two parts by a thick head wall. The up-stream part contains wheel chambers for seven 1,000 H. P. wheels, of which five only are at present occupied. The down-stream portion contains the wheel governors and the electrical apparatus. The length of the power house proper is 257 feet 6 inches; the width of the dynamo room between head wall and south wall 34 feet, and the width of the wheel chamber portion 32 feet 6 inches. The total width of the power house is 66 feet 6 inches. At the western end an L extension runs up-stream, 87 feet 5 inches long and 44 feet 10 inches wide. This portion of the power house is of brick. A retaining wall runs down-stream from the power house along the western bank a distance of 50 feet. The western stream running between the bank and the island forms the fore-bay, 300 feet long. The main tail race is 205 feet wide and joins the main stream 750 feet below the power house.

Arched chambers are provided for seven main wheels and two exciter wheels. Each main chamber is 32 feet 6 inches long, 22 feet wide, and 17 feet 5 inches high, and is provided with two 6-foot manholes. Each exciter wheel chamber is 32 feet 6 inches long, 17 feet 5 inches high, and 10 feet wide. The head wall of the chambers is 6 feet thick, the wall on the up-stream and both sides 3 feet thick. In the head wall of each main chamber is set a heavy cast iron cover through which the turbine shaft passes in a water-tight packing box, carrying the ring oil bearing for the shaft. The saving in space effected by the new arrangement of housing and coupling together of the turbines, patented by the Stillwell-Bierce & Smith-Vaile Co., has tended to diminish considerably the size of the power house.

A 20-ton crane from the works of Pawling & Harnischfeger, Milwaukee, runs the entire length of the dynamo room.

In front of the wheel chambers and running the entire length of the power house is a trash rack of steel bars supported on a frame-work of steel channel and I-beams. This rack effectually prevents access to the wheels of any rubbish or floating material that may escape the boom.

Main Wheels.

The main wheel plant consists of ten pairs of 42-inch

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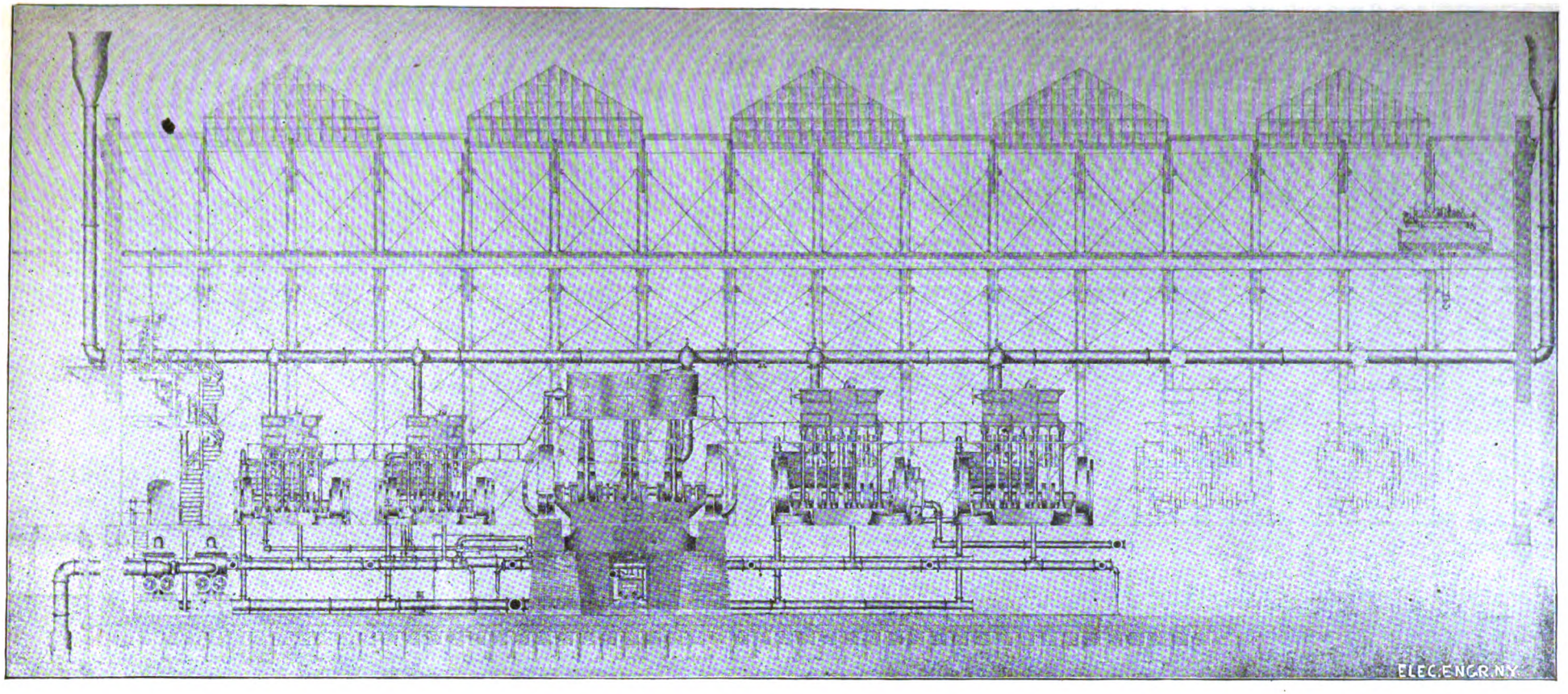

(Chicago Edison Company.)
A Modern and Model Power Plant.

horizontal Victor turbines of the latest type, built by the Stillwell-Bierce & Smith-Vaile Co., of Dayton, O. Each main turbine consists of two pairs of wheels, which at the normal speed of 114 revolutions is rated at 250 H. P. The total power of each set of turbines is, therefore, 1,000 H. P. Five units are now in position; the two additional turbines will be installed shortly. The head under which the water wheels are operated is 18 feet.

(To be continued.)

Ashcroft, B. C.—The Ashcroft Water, Light and Power Co. will erect a power house on the Bonaparte river, about three miles from here, and install an electric light and power plant.

REPAIRS OF ARMATURE, COMMUTATOR AND FIELD.

LESSON LEAVES
FOR
THE AMERICAN SCHOOL OF ELECTRICITY.

BY NEWTON HARRISON, E. E.

(Continued on page 124.)

A burnt-out field indicates itself by a peculiar aroma of scorching cotton and shellac. If this occurs to one of the inner layers it will not be perceptible, but a heavy ground will result, and the smell of burning insulation will be an additional proof. If the field is reversed, the

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proper connections can be very easily made, and if it heats to any unusual extent without actually burning, the coil has been poorly designed; its radiating surface is insufficient, and one of the best remedies is to interpose a resistance in its circuit so as to decrease the current flowing through it, and speed the armature up a little higher by the use of a smaller pulley, to keep the voltage the same as before. If the coil is merely grounded, and any anticipation of danger is felt by the engineer, the ground may be discovered between the terminals of the coil and the framework of the machine. In a new machine it may be likewise due to moist shellac; or if the coil is wound upon a metal sleeve, it probably exists in the innermost layer, and had better be left alone. It is always best for the engineer to test for his fields by holding some iron object firmly in his fingers and bringing it to either pole or poles of the machine, or the polarity can be directly ascertained by means of a compass.

Model Plants.—The expression "model plant" is self-explanatory. To the engineer, a perfectly equipped system of electric light appeals as strongly to his sense of beauty and idea of completeness as a work of art, of sculpture or of rare design. A harmony can exist in the engine room or station that suggests at once the touch of a skilled hand and comprehensive view of an experienced mind.

To construct a model plant is not only to set up an engine and dynamo on a substantial foundation, but to have in addition to these the latest and best accessories for its smooth running, its ready supervision and economical handling. A model plant should never be wasteful, as the very object of having an elaborate outfit is to prevent or reduce the expense of operation. A model plant should not be a source of constant bother; it should not necessarily include self-acting devices, which are too impractical and, therefore, unreliable for continued use. It has been discovered, in the majority of cases, that the beauty of a plant begins at the boilers and extends from there to the engine room. The essential parts of a model plant are—

An efficient boiler,
An automatic engine,
A self-regulating dynamo.

An efficient boiler can only be considered as such when its power of making steam is great in comparison with the weight of coal consumed. In all boilers a considerable quantity of unburned fuel escapes as smoke. Heat is wasted from the furnace, boiler shell, steam pipes, etc.; the very smoke that escapes is due to lost heat. An efficient boiler, as ordinarily understood, would be one a little better than the others. But supposing this slight gain in efficiency adds a greater item of expense to the price of the boiler or necessitates such extra labor that the additional efficiency becomes a plague and a nuisance, there is evidently no gain in using a boiler of this kind. Here is a statement which will give an idea of the amount of power wasted between the furnace and the engine: "It has been satisfactorily demonstrated that in the very best engine, even if it were theoretically perfect, and working at ordinary ranges of temperature, only somewhere about one-fourth of the heat which is actually employed is converted into work; that is to say, three-fourths of the coals, or three-fourths of the heat employed, are absolutely wasted under the most favorable circumstances." Boilers are on the market today which are far superior to any previously introduced, which may use culm, the cheapest product of the mine, and in cheapness and serviceability highly commendable. The weight of coal consumed for a given quantity of steam can be otherwise put as the weight of coal consumed for a given amount of energy—so many pounds per horse-power hour. About two and a half to three pounds per H.-P. hour is the best point reached in practice with triple expansion engines. The weight of coal may increase as high as five or six pounds per H.-P. hour in poor engine equipments.

An automatic engine is one which can regulate with changes of load; that is to say, keep its speed constant. This is very necessary with a dynamo attached, as a reduction of speed with an increase, or a raising of speed with a decrease of load would mean either a poor light from the lamps or an exceedingly bright light from them; the poor light fading with each new circuit thrown in, the bright light becoming dangerously stronger, to the detriment of its filament with a higher speed, due to the lesser load. A model plant must therefore have an engine of uniform speed, and as unchangeably so as possible. It must have an efficient boiler, which is clean and provided with the proper attachments for its protection, and the necessary heating surface, so as to burn its coal economically and well.

A self-regulating dynamo can only be called by that name if it fulfils the functions expected of it—if it sustains one pressure throughout all change in the lights; if it is automatic; in other words, if it regulates. The best machines of today are of the multipolar type. They are not model machines, and cannot be considered a desirable addition to a model plant unless they regulate; do not heat, either in field armature, bearings or commutator, and do not spark at the brushes. A dynamo from a mechanical standpoint is a simple piece of mechanism. It is not difficult to attain comparative perfection in this respect, and such perfection is essential. The electrical designer must provide the proper surfaces and cross sections for the radiation of heat. The current squared multiplied by the resistance in fields and armature respectively give the value of this in watts. The good design of a dynamo greatly depends upon the ability of its armature to radiate heat. Sparklessness is a feature which above all things should be absent.

A model plant can but begin to be such when a boiler, engine and dynamo meet these purely practical demands herein outlined. A switchboard containing voltmeters and ammeters, automatic cut-outs and ground detectors; a system of switches which places every circuit of consequence under the engineer's control, complete so necessary an adjunct to a complete plant. It becomes a model plant when the room is lofty and well lighted; when the engine and dynamo are upon solid foundations; when vibration is entirely absent and only the low murmur due to the perfection of such mechanism reaches the experienced ear.

QUESTIONS FOR REVIEW.

(1) Of what parts is the dynamo composed?
(2) What are the causes of grounds?
(3) How is a coil repaired?
(4) What ailments may attack a commutator?
(5) How is a burnt-out field discovered?
(6) What are the essential parts of a model plant?
(7) What is an efficient boiler?
" " " automatic engine?
" " a self-regulating dynamo?

TRANSFORMER ECONOMY.*

By Professor Winder Elwell Goldsborough, Purdue University, Lafayette, Indiana.

A great deal has been said and written about the static transformer of alternating currents, and yet we are only just beginning to understand this much-discussed piece of apparatus. The manufacturers have made it and ex-

* Read before the National Electric Light Association at its twenty-first convention, held at Chicago, Illinois, June 7th, 8th and 9th, 1898.

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perimented with it, the theorists have experimented with it and disputed over it, the underwriters have disputed over it and endured it, and the central station men have endured it and made use of it to the great good and comfort of the publie. No other piece of apparatus in the field of electrical engineering has been lauded higher or been the subject of greater abuse, and to all it has served a purpose.

Today the transformer occupies a higher position than ever before, and it grows in importance as each new development in the field of applied electricity points out a new department of usefulness for it.

There has, however, been enough agitation lately on the part of manufacturers, in behalf of substituting new types of transformers for the old ones now in use, and of relegating the small transformer to the scrap heap, to cause the central station men, who are responsible for the successful operation of alternating current generating plants, some unrest. The foundations of many of these plants were laid before the time of skilled designers of electrical machinery, and at a time when the factory motto was "cut and try." As the public demands increased, the plants developed and expanded before the practical men were amenable to "theories," and before the exact methods of the laboratory had become the daily practice of the constructing engineer. Managers see that engineers are still making mistakes, and that faulty design is still a factor in electrical development, and when they call to mind the enormous sums of money that have been spent in this country on ill-advised improvements it is not to be wondered at that they hesitate.

There is, however, a gradual change for the better in the number of the yearly contributions to the records of our electrical societies, and as these records are the expression of the best thoughts of the men who have made America famous as the land of electricity, they may be taken as signs of the times in our department of engineering activity.

We are constantly impressed with the fact that the refinements of exact scientific methods are being made the subject of every-day discussion, and that the more difficult problems of the technical side of the profession are being so well elucidated by our "practical theorists" that it is possible for all of us to enjoy a concrete appreciation of electrical science without an excessive expenditure of mental energy on the theoretical.

We are coming to a time when exact methods will be the universal rule and when the reputation of having a high "guessing factor" will no longer be a sufficient recommendation.

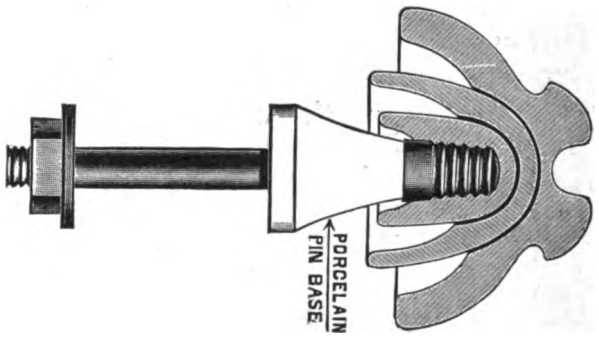
These influences are noticeable in the improved electrical intelligence of our workmen, as well as of our station engineers, and I find that it extends even to the general public. Indeed, a careful record of the number of times that I am asked "how does the little trolley wheel push the car along?" shows a yearly decrease of nearly 50 per cent.

So we see that matters adjudged to be of slight importance a few years ago are being allotted their normal position. A fault is a fault at the present day, and is not often disregarded as "too small to be appreciable." The old saying that "if you take care of the pennies, the dollars will take care of themselves," applies just as well to electrical engineering as it does to other professions, and it is the "pennies" that I am about to deal with.

(To Be Continued.)

HIGH INSULATION LINE MATERIAL.

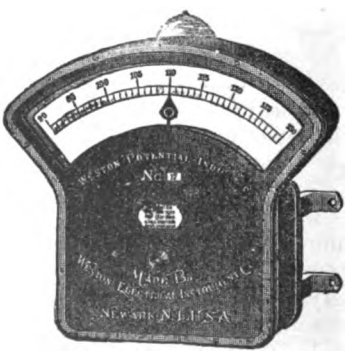
The triple petticoat porcelain insulator represented in this illustration is made from three shells of vitrified china fused together with glaze. A variety of sizes are made capable of withstanding potentials of from five thousand to fifty thousand volts. The manufacture of insulators for transmitting high pressures has developed into a high science. Many dozens of power plants installed in different parts of the Union transmit enormous pressures over lines in some cases twenty-five miles long. The safety and economy of the system depends almost entirely upon the insulators used. The strength and high insulating properties of the insulators sold by Frederick M. Locke, of Victor, N. Y., have secured for their manufacturer a national reputation. Mr. Locke has made practical tests of the insulator represented above, and it has been found capable of withstanding a pressure of one hundred thousand volts, which is certainly a sufficient guarantee of its efficiency in transmission work.



Triple Petticoat, Porcelain Insulator—Made from Three Shells of Vitrified China, and Fused Together with Glaze. Made in Several Sizes for Potentials 5,000 to 50,000 Volts.

The complete absence of metals from the earths of which this insulator is made, the impossibility of the insulators deteriorating or cracking, has in addition to their capability of resisting gases and acids brought them into great demand by electrical engineers. Their high insulation resistance reduces leakage down to the lowest possible point, thereby securing for the purchaser the best article the market affords and a moral satisfaction in having obtained the best that money can buy.

WESTON STANDARD ILLUMINATED DIAL



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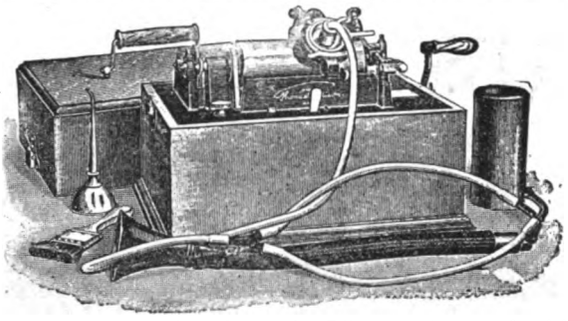

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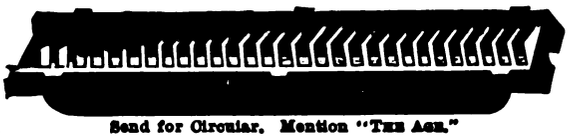

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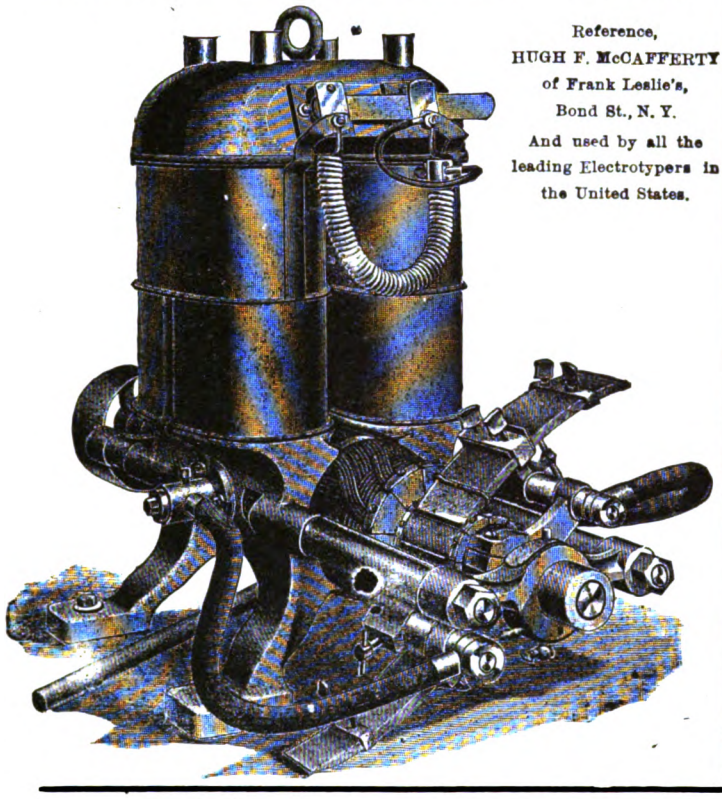

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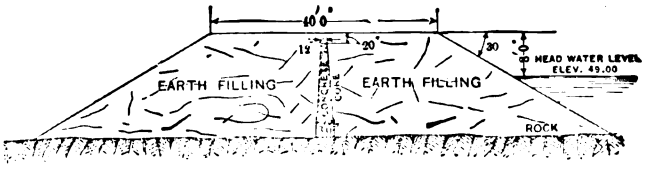
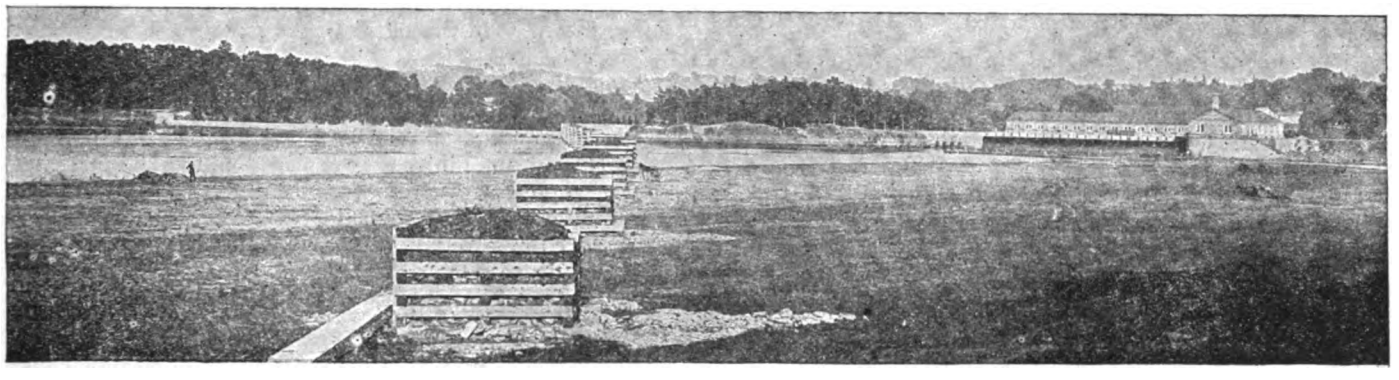
The Electrical Age.

VOL. XXII—NO. 11 NEW YORK, SEPTEMBER 10, 1898 WHOLE NO. 591



Section Through Earth Embankment.

The Power Before Development.



The Development of the Power.

MECHANICVILLE.

(Continued from page 136.)

Generators.

The dynamo room is a spacious chamber well lighted by windows on all sides. It is 255 ft. long and 34 ft. wide, 30 ft. 5 in. in the clear from floor to roof truss and 22 ft. from floor to crane. The ultimate generator capacity of the station is 7,000 H. P. in seven generators, each of 750 K. W. capacity. Five have been installed and are now running. They are unitooth, three-phase, forty-pole, 750 K. W., 114-revolution, alternating-current machines, having revolving fields and stationary armatures, and wound to deliver 36 amperes of current at a periodicity of 38 cycles and a pressure of 12,000 volts to the transmission lines. They are arranged for operation in parallel at constant voltage. By using the revolving-field type of generator and thus securing this pressure directly from the machine, the use of step-up transformers to raise the voltage for transmission purposes is avoided. As the current is to operate synchronous and induction motors, to operate lights and to be converted into direct current through rotary converters, a frequency of about 40 cycles was selected as most suitable for the different conditions required.

The alternators are similar in their main characteristics to those successfully used in the development of the power of the Lachine Rapids at Montreal. The armature frame or ring is of the box type, 15 ft. 4 in. in diameter and 36 in. wide. It is bolted to a base 18 ft. 2 in. long by 10 ft. wide, along which it may be moved parallel with the shaft, in order that the revolving-field spider and poles may be uncovered should occasion arise. The armature winding is protected on each side by iron shields. The pillow blocks are also bolted to the base and the bearings are of the spherical-seated self-oiling type used in all General Electric generators.

The field ring is bolted to the spokes of the spider. It carries 40 poles, each securely fastened by two bolts to the ring. The whole revolves on a shaft 15 in. in diameter, provided with a rigid coupling on the turbine side, bolted to a similar coupling on the turbine shaft. The dynamo shaft is extended for coupling to a vertical steam engine, in case of necessity.

The following reasons for selecting this type of alternator have been given by Mr. C. P. Steinmetz, of the General Electric Co.:

In addition to the advantage which the stationary-armature type has over the stationary-field type in allowing a high transmission voltage to be taken directly from the armatures, it allows of a fairly low saturation of the magnetic circuit, giving an almost straight saturation curve. This is preferable in power transmission, since a considerable increase in the voltage

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may be obtained, if needed, to cover excessive drop in the lines due to heavy loads, and the voltage may be maintained even if the speed remains low.

Exciters.

The exciters are placed one on each side of the stairway leading to the switchboard gallery. They are

A Shipment of Victor Turbines.

6-pole, 100 K. W., 125-volt standard General Electric machines, with ribbed field frame and iron-clad armatures.

Switchboard.

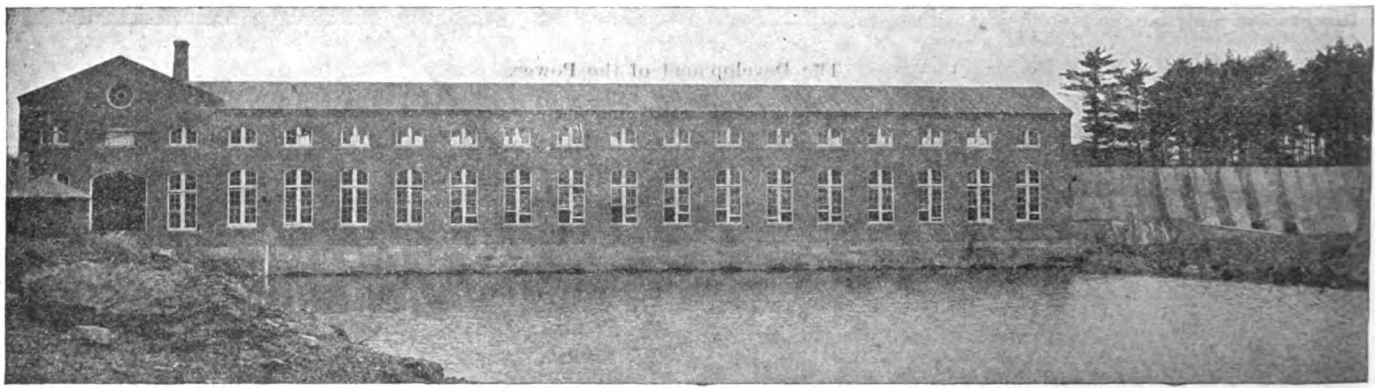
The switchboard, erected on a gallery on the north wall of the dynamo room, is built up of nine highly polished panels of blue Vermont marble, each panel 7 6 in. high, 3 ft. 0 in. wide, and 2 in. thick. Of these nine panels, five are used for the generators and two for the feeders; one is the total-output panel, and the last is for the control of the exciters. The generator panels occupy the left side of the board, and room on the gallery is left for two additional panels. The feeder panels are on the right side; the total-output panel is between these and generator panels, and the exciter panel is the third panel from the left-hand end of the board.

Each generator panel is equipped with the following instruments: One inclined-coil alternating ammeter reading to 75 amperes for the generator, and one direct-current ammeter reading to 150 amperes for the field. Above each of these is a pilot lamp, and between each pilot lamp a synchronizing lamp. Beneath the two ammeters is an inclined-coil voltmeter reading to 15,000 volts, and beneath this instrument are three single-blade, double-throw, quick-break, high-tension switches, each mounted upon pyramids of corrugated hard rubber. Similar pyramids intervene at the back of the board between the bus bars and the board. The corrugations give a total distance of about 8 in. of surface between the metal clips and hinge and the surface of the marble on each side. As these switches are to break current of 12,000 volts, they are tested to break without difficulty currents of 21,000 volts. The switches are without handles. An eye is made in the end of each blade, into which a hook at the end of a stick may be inserted and the switch opened by the attendant from a safe distance. Further, to prevent any dangerous arcing from blade to blade, marble barriers 1 1-4 in. thick, 3 in. long, and 12 in. wide from the face of the board, are erected between each blade.

On the left-hand side of each generator panel subbase are two 100-amp., double-pole, double-throw, carbon break-switches—one the field switch, the other the lighting switch. On the back of the panels are the high-tension fuse blocks.

These fuse blocks, designed for 20,000 volts, are of the snap-break expulsion type. They are mounted on pyramids of corrugated hard rubber, which contain copper spring contact clips, between which two copper blades enter, connecting the fuse block to the line. The aluminum fuse is held tightly between two arms, which are moveable around a pivot and may be pulled apart by two strong spiral springs encircling this pivot. As soon as an increase of current in the line melts the fuse, its two halves are instantly pulled apart, and thus the formation of an arc between the two halves is prevented. The melting of the fuse can only occur in a small chamber protected by wooden blocks. The whole device is covered by two vertical wooden boards. Sliding in between these wooden boards, in vertical slots, are fibre shields intended to prevent arcing over between the two arms after the separation of the two halves of the melted fuse. The two wooden blocks and fibre shields are held in position by four screws. The whole fuse block is inserted in the line simply by pushing the two blade-like copper contacts between the clip contacts, which are connected by solid copper rods to the bus bars. The wooden boards protecting the fuse are 10 1-2 in. long and 6 3-8 in. wide. The corrugated rubber pyramids on which the contacts are mounted are 3 1-2 in. high. The field rheostats are hung beneath the gallery, and are operated by hand wheels on the gallery and bevel gears below it.

The exciter panel controlling the two direct-current



Down-stream Side of Power House and Tail Race.

exciters carries two pilot lamps, two circular dial ammeters, each reading to 1,000 amperes; one voltmeter, reading to 150 volts; one four-point pressure switch, one synchronizing switch, two 800-ampere, triple-blade, double-throw equalizer switches, and two packed-card rheostats.

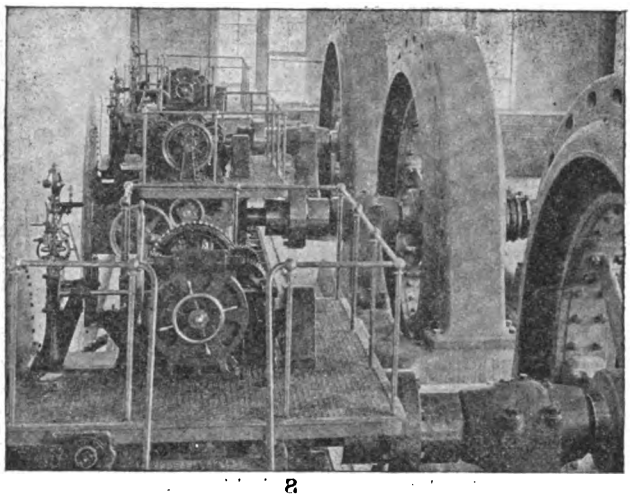
The two feeder panels are similar to each other in every respect. Each outgoing line is provided with an independent ammeter, reading to 150 amperes, and a quick-break, double-throw, high-tension switch similar to those on the generator panels and similarly mounted on the board. Mounted also on corrugated hard rubber pyramids are six circuit breakers, or automatic plunger switches.

These high-potential plunger switches consist simply of long copper rods sliding in hard rubber tubes. The upper ends of the rods reach into small rings in contact with which they are held by a lever catching a small rubber head on the lower end of the copper rod. This lever is held in place by a spring, and is released by moving a rocker arm on the back of the switchboard. The moment it is released a spiral spring pushes the copper rod downward, and by this movement, aided by the action of gravity, so suddenly is the contact broken that arcing between the rod and the ring is prevented. The rocker arm controls the three switches for each set of bus bars, so that they may be all released at once.

On the upper part of each feeder panel at the back is a current transformer for each outgoing line, two recording single-phase wattmeters, each reading to 25 amperes and 12,000 volts, and two potential transformers.

On the front of the output panel are two Thomson recording wattmeters for balanced three-phase circuits, each reading to 300 amperes and 12,000 volts, and twelve triple-pole, single-throw, 100-ampere switches, with fuses for the lighting circuits. On the back are four potential and two current transformers.

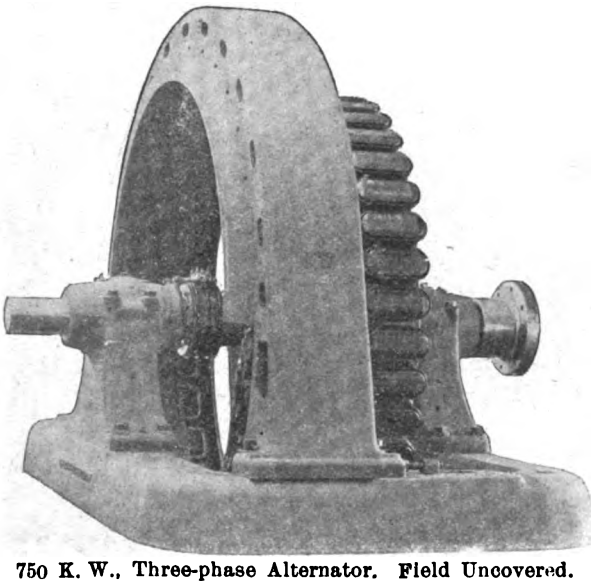
The lightning arresters are of the G. E. short-gap type.



Main Wheel Governors, Tiesler Type.

Arresters of this type have been installed on nearly all of the most important long-distance transmission lines in this country, and have proved a most satisfactory protection against damage by lightning.

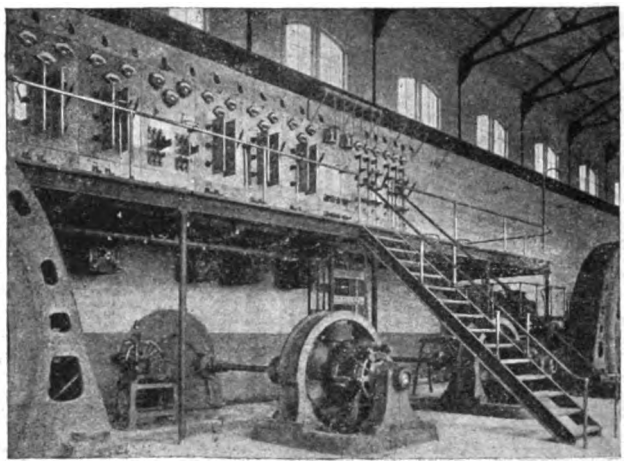
The principle on which this arrester operates is very simple. It allows the passage of any high-potential discharge, but effectually prevents the alternating current from following and maintaining an arc. The gap spaces in the lightning arresters at Mechanicville are very small —about 1-32 in.—each space lying between two solid metal cylinders 2 in. in diameter and 2 in. long. A low non-inductive graphite resistance is placed on the circuit, and the action of the arrester therefore is dependent upon the cooling effect of the large metal cylinders, aided by the reversal of the alternating current and the introduction of the non-inductive resistance. The line is protected by double-pole, 2,000-volt arresters, connected six in series to give the necessary number of spark gaps. There are three sets of these. One at Mechanicville, grouped around the first transmission pole in a small house 15 ft. square; one set on the Schenectady side of the Glenville bridge, where the overhead pole line connects with the underground cable; and at the Works.



750 K. W., Three-phase Alternator. Field Uncovered.

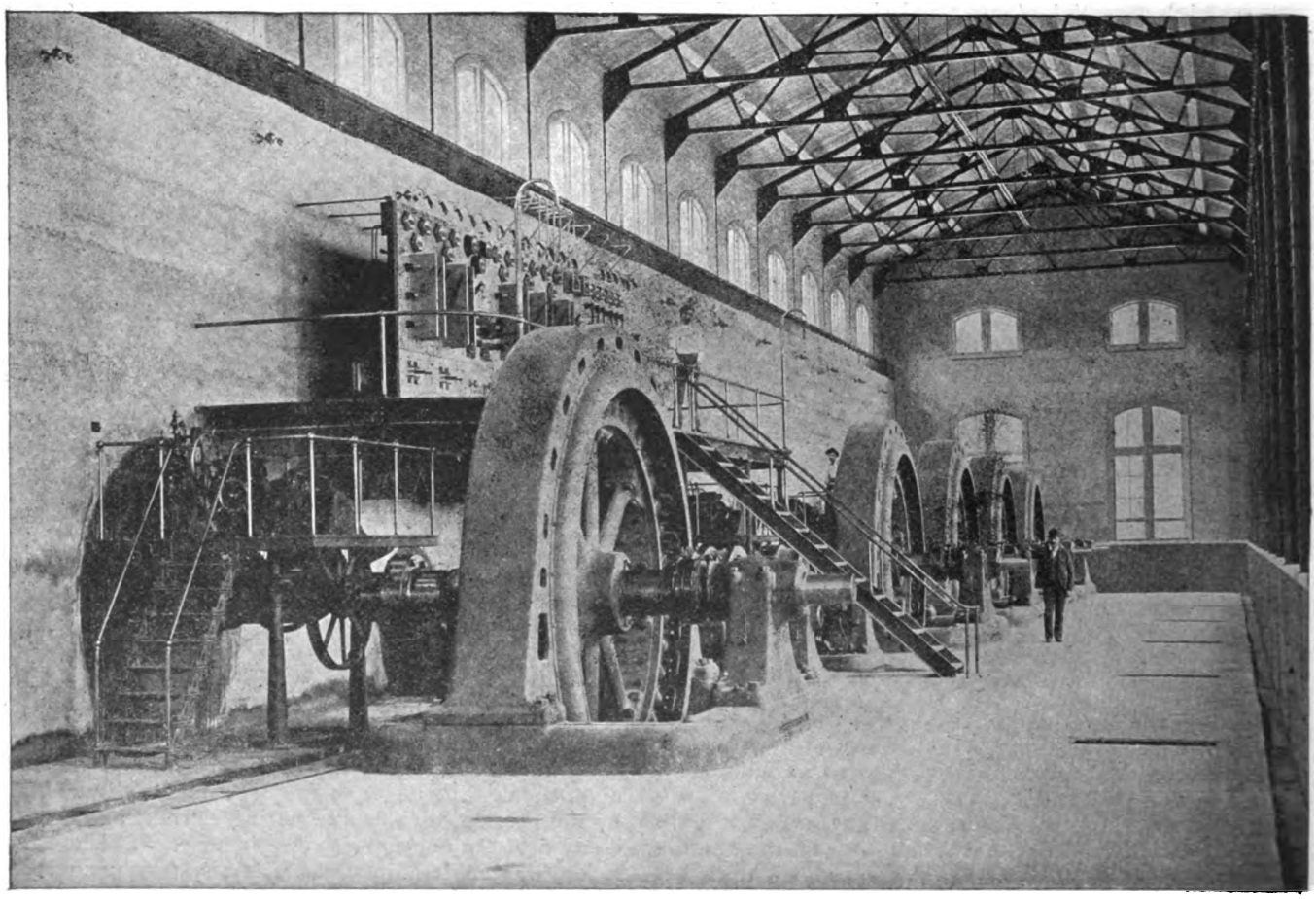
The lead-covered leads from the generators are taken out at the base of the machine and are laid in ducts in the floor. Rubber-covered wire is used for the field connections. The cables rise on a frame from the duct to the floor of the gallery, through which they rise to the board. From the back of the board the line wires rise to supports bolted to the I-beam on the north wall, which supports one of the crane runways. The lines run along the north and west walls and pass out to the poles through a blind window over the door of the power house.

The line from Mechanicville to Schenectady is the only one at present laid down. It consists of three No. ooo B. & S. band wire, this large gauge being employed in order to give the line as high self-induction as possible. This insertion of self-induction in transmission lines is a departure from earlier practice. In cases where synchronizing apparatus is used, self-induction is now considered necessary, and is artificially brought into the line in the shape of reactive coils in cases in which the natural self-induction is too small. The circuits are carried on poles 30 to 60 ft. long, and all 8 in. in diameter at the top. Each pole carries one cross arm, on one side of which are two porcelain insulators of the triple-petticoated type, a third being on the other side. For lightning protection a barbed wire, frequently grounded, runs along the tops of the poles.



Exciters and Switchboard.

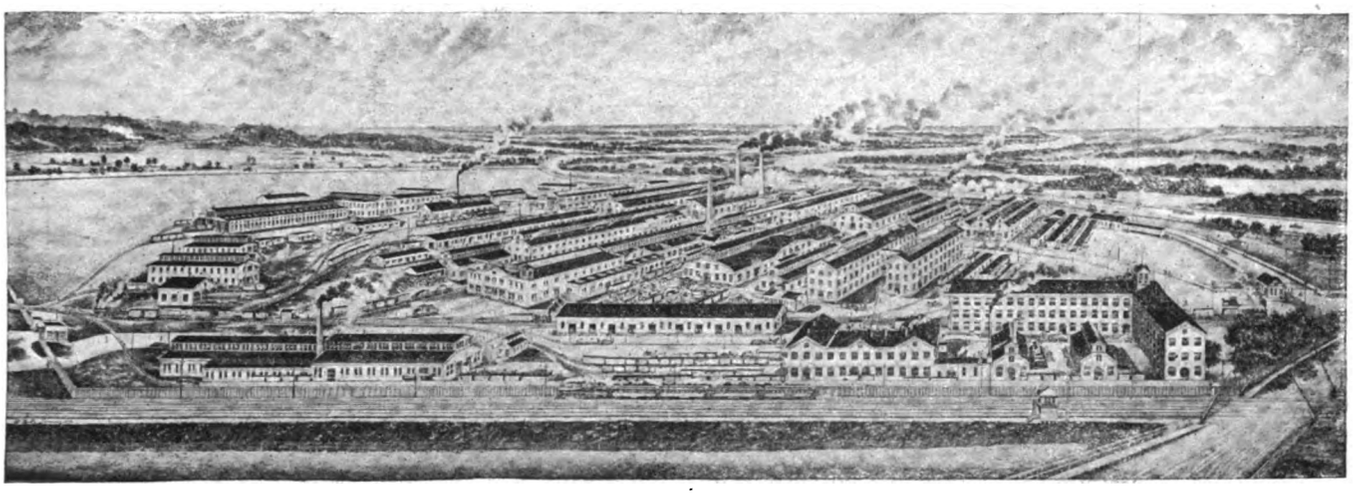
The line takes a westerly direction to East Glenville and then due south to Schenectady. At the end of the Glenville bridge over the Mohawk—the town limits—it is carried down to the ground and connected to three cables of No. 1 gauge stranded copper, insulated by 1-4 in. rubber and 3-32 in. lead sheet laid in terra-cotta conduits. These cables run 1,700 feet along Washington avenue, rise to poles again through Rotterdam street to the Erie



Interior of Power House. Dynamo Room.

Canal, and along the canal to a point directly opposite the General Electric Company's power station. They then cross the canal and enter the Works.

The introduction of this transmitted electrical power into the factory will work a considerable change. At present all the machinery is driven by electric motors, while the testing department demands an independent supply of current for the work it carries on. There are at present, therefore, two distinct generating plants. The 550-volt motors in the testing department are supplied from an engine-driven multipolar generator of 500 K. W. capacity, while a smaller engine drives a number of exciters which allow of independent control of the excitation of all machines in this department. The factory is operated by a number of 250-volt motors running on the same circuit as the factory lights. These motors will not be changed, and the steam plant which supplies them will be retained as a reserve in case the power from Mechanicville should fail. The electric power plant superseding the present steam plant at the works will, therefore, consist of two synchronous motors, one of 500 K. W., the other of 100 K. W., and three 400 K. W. rotary converters—the synchronous motors for the testing department, the converters to supply current to the factory motors.



The Schenectady Works, General Electric Co.

The large engine driving the 500 K. W. multipolar generator is superseded by the 500 K. W. synchronous motor. This is a 12-pole, 400-revolution machine of the revolving field type, wound directly for 10,000 volts. The small engine driving the exciters is replaced by the 100 K. W. synchronous motor—an 8-pole, 600-R. P. H. revolving field machine similarly wound. This disposition renders this department independent of everything but the speed of the Mechanicville generators, which will be kept as nearly as possible constant.

The three rotaries supplying 250-volt current to the factory motors are 10-pole, 400-K. W., 480-R. P. H. machines, having two commutators and two sets of collector rings, connected to independent windings on the armature. They receive the three-phase current from independent secondary coils of the same set of air-blast transformers. When connected in multiple they furnish current at normal pressure of 250 volts, but, as they may be called upon to furnish current to the testing department in case the demand exceeds the supply from the synchronous motor-driven machine, they may be connected in series to give 500-volt current, operating in parallel with the railway generator, driven by the synchronous motor in the testing department.

The rotaries are operated in parallel, and all the factory motors, the factory railway and all the factory lighting are operated from the same direct-current circuit, the latter on the Edison three-wire system, the neutral wire of the three-wire system being secured by connecting the transformers for the rotaries in Y with their secondaries and bringing to the neutral a lead from their common connection.

Synchronous motors were selected in preference to induction motors on account, first, of their more constant speed and greater efficiency; second, because they do not produce lagging currents; but the phase displacement and power factor may be controlled as desired by means of control of the field excitation.

Synchronous motors of the revolving field type and of good design are self-starting, even under heavy load, and will easily carry two or three times full load without falling out of step for a time, limited only by the heating of the motor.

To make the entire Works system self-regulating in the direct-current distribution and, as far as possible, independent of hand regulation, the rotary converters are given shunt field and powerful series field, so joined together that the machines operate as one unit. With constant voltage in the generating station at no load, the counter E. M. F. of the rotaries as given by their shunt field is below the impressed E. M. F. and a lagging current is produced. The self-induction of the lines is thus in opposition to the voltage, which is so reduced as to give 250 volts at the commutator brushes of the rotaries. As the load increases, the counter E. M. F. of the rotaries rises, due to the series field, until at full and over-load it is greater than the impressed E. M. F., and the current becomes leading. The E. M. F. of self-induction of the lines is then brought partly in phase with the voltage, which is increased so that, in spite of the increased line current and consequently increased energy loss in the line, with constant generator voltage, the same voltage is produced at the commutator brushes of the rotaries at no load as at full load and over-load. This control is, therefore, automatic in every way and, did the synchronous motor not take current over the same line in varying quantities, would suffice. To render this control perfectly automatic, therefore, small series transformers are inserted in the lines leading to the synchronous motor, feeding a small synchronous motor generator controlling the shunt field of the rotaries. By the combined action of their shunt and series field, the voltage is automatically maintained constant at the commutator brushes of the rotaries, and no hand regulation is required beyond that of readjustment in case the number of rotaries in operation is changed.

The entire construction of the dams, power house and lines has been carried out with the highest engineering skill by the National Contracting Company, of which G. H. Furman is general manager, E. A. Mathews, superintendent, and J. A. Leonard constructing engineer. The electrical equipment is furnished by the General Electric Company, and the hydraulic equipment by the Stillwell-Bierce & Smith-Vaile Co., of Dayton, O., to which com-

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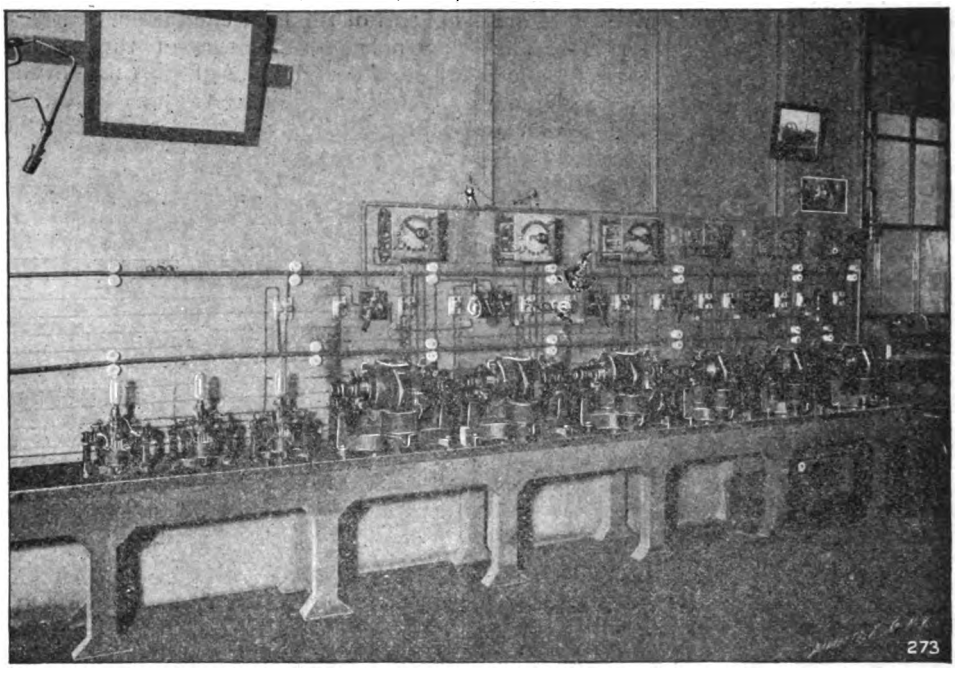
pany was confided the entire development contract. It took the Hudson River in its natural condition and turned over to the operating company the plant in running order.

The officers of the Hudson River Power Transmission Company are:



Electrically Driven Telegraph Plant. 20 Dynamotors. Western Union Telegraph Co., Buffalo, N. Y. 1894.

General Edmund Hayes, of Buffalo, N. Y., president; R. N. King, president of Stillwell-Bierce & Smith-Vaile Co., of Dayton, O., vice-president; G. H. Furman, Newark, N. J., treasurer; Mr. E. J. Richards, Boston, Mass., superintendent; J. S. O'Shea, manager.

Electrically Driven Telegraph Plant, 25 Dynamotors. Postal Telegraph Co.. Main Office, New York. 1894.

WEAVING BY ELECTRICITY.

One of the oldest arts in the world is that of weaving. The fabrics of the Far-East, including India, China, Japan, Turkey and Persia, have been famed from time immemorial, and even today the textile products of these countries represent one of their most important sources of revenue.

It is universally acknowledged that hand-made rugs, shawls, carpets, etc., fetch a higher price than those made by machine, but the consumer of today is one supplying profit to thousands of manufacturers by buying the less valuable though just as serviceable machine-made textile goods.

When the looms of England were driven by steam great riots resulted, but as people grew accustomed to this innovation those that fought against it found themselves better paid and consequently better clothed, fed and housed, and the direct use of the hand came into play for the manipulation of great machines.

Electrically driven looms, as repesented in this illustration, appeal to our sense of progress as the next and most reasonable step and advance. It is likely that the introduction of the motor for driving weaving machinery will become so widespread as to ultimately affect the price of woven goods for the benefit of the purchaser.

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The Electrical Age.

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A USEFUL PRODUCT OF THE ELECTRIC FURNACE.

Practical investigations and experiments have shown the commercial world that carborundum, a product of the electric furnace, is exceedingly valuable and may replace many of the materials formerly used for grinding and polishing. Carborundum, or carbide of silicon, is prepared in a furnace consisting essentially of a large metallic receptacle, a carbon rod supported in the middle and a mixture of carbon and clay, through which a very strong current is passed, the holder of the material and the carbon rod serving as electrodes. In a furnace of this description a fusion of carbon and clay takes place, with the result that in the course of time, after the gases, etc., have escaped and the furnace is allowed to cool, clusters of crystals have formed inside the interior of the mass, presenting the appearance of a geode.

This primitive form of furnace has undergone several modifications since the value and utility of corborundum have been recognized. Mr. Atchison, a gentleman whose name has been connected with the development of the trade in carborundum, used glass sand and a little salt instead of clay, thereby producing a much purer type of carbide of silicon than ever before.

The heaviest amounts of carborundum manufactured did not exceed one-quarter of a pound per day, but since a demand for it has increased, thousands of pounds are produced per week in very large furnaces, some of them over nine feet long. It requires about two thousand horse power hours to produce three hundred pounds of carborundum, or an average of seven horse power hours per pound. The mixture which is shovelled into the furnaces at Niagara Falls consists of a well-reduced mass of heterogeneous materials, such as coke, saw dust, sand and salt, which, in certain proportions of each, are reduced in a furnace to continued incandescence and subsequent crystallization.

Wherever power is cheaply developed there are sufficient manufacturing concerns in the immediate vicinity or within a radius of limited extent able to use many pounds of carborundum, in consequence of which making it a paying investment to erect a plant for that purpose. This represents the conditions met with at Niagara Falls, at which the Carborundum Company have established their plant. The details of construction and technical features of this establisnment are deeply interesting to the electrical engineer. It is surprising to realize how short time has elapsed since the discovery, use and manufacture of carborundum has become a fixed thing. As this material will scratch and cut all precious stones but the diamond, it necessarily follows that its field of application is enormous, and such is the case.

Emery wheels have found a great rival in those made of carborundum, and the various powders sold for polishing and preparing the surfaces of metals have been set aside for this new, strange, and, in many respects, remarkable product.

Within the furnace in which carborundum is formed pieces of pure carbon are found. The coke is exposed to so great a temperature that it is reduced to the purest graphitic form. Many of the carborundum crystals are quite light in color and might be mistaken for a diamond if cut and polished. The products of the electric furnace, in the form of acetylene or carbide calcium and carbide of silicon, carborundum, are now of the greatest service to the domestic and industrial world.

We can trace some of the most brilliant discoveries of earlier chemists to simple experiments with the electric furnace, and it is highly likely that the list will not end with carborundum, which is, in most of its characteristics, the nearest semblance to an artificial diamond, with the exception of Moissan's gems, that we have produced. As a further proof of this last fact, we may state that a sheet of glass was scratched with a crystal of corundum, carborundum and the diamond. Upon examination of these scratches with the microscope, the discovery was made that the lines made by the carborundum and diamond were identical. As far as its competition with emery is concerned, not the slightest doubt remains in the minds of practical men regarding the infinite superiority of this unique crystal.

THE RISING PRICE OF RUBBER.

Two indispensable materials to electrical manufacturers are rubber and copper. As far as the latter is concerned the great mines of this country have and will produce sufficient to meet all our requirements. The great Anaconda mines of the West, supply millions of tons per year to the East and other large institutions of a similar nature, making a temporary exhaustion of this valuable metal almost impossible. But the item of rubber which is used for the insulation of wires is one requiring serious consideration. The United States is forced to obtain its supply of rubber from South America. Perhaps no more profitable investment could be made by a shrewd capitalist during these times than in a tract of ground filled with rubber trees.

The demand for rubber has grown of late far beyond the expectations of the most sanguine-minded. Rubber bicycle tires, rubber wearing apparel, a host of medical appliances, and finally, rubber-covered wires, have caused the supply to be unequal to the demand—a demand which increases daily. An excellent opportunity is presented here for some ingenious inventor to produce a substitute for rubber, if not for all the other purposes mentioned above, at least for the insulation of copper conductors.

Foreign chemists and Prof. Fessenden suggested the use of cellulose, and we believe that its high insulating properties, durability, etc., make it well worthy of trial. In a note received from Consul-General De Leon, of Guayaquil, the statement is made that the culture of rubber trees has been started in Ecuador, in which rubber was previously obtained from wild trees. The goverment is taking an active interest in this matter and Ecuador may be regarded in the future as one of the important centres of supply.

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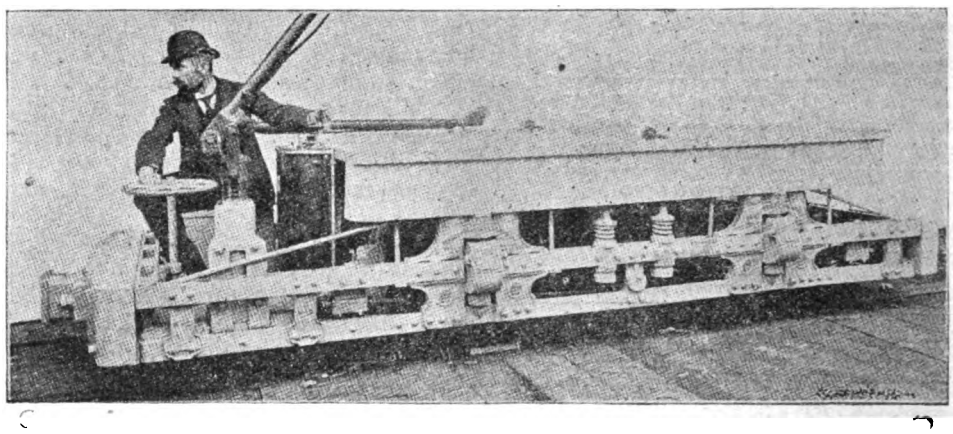
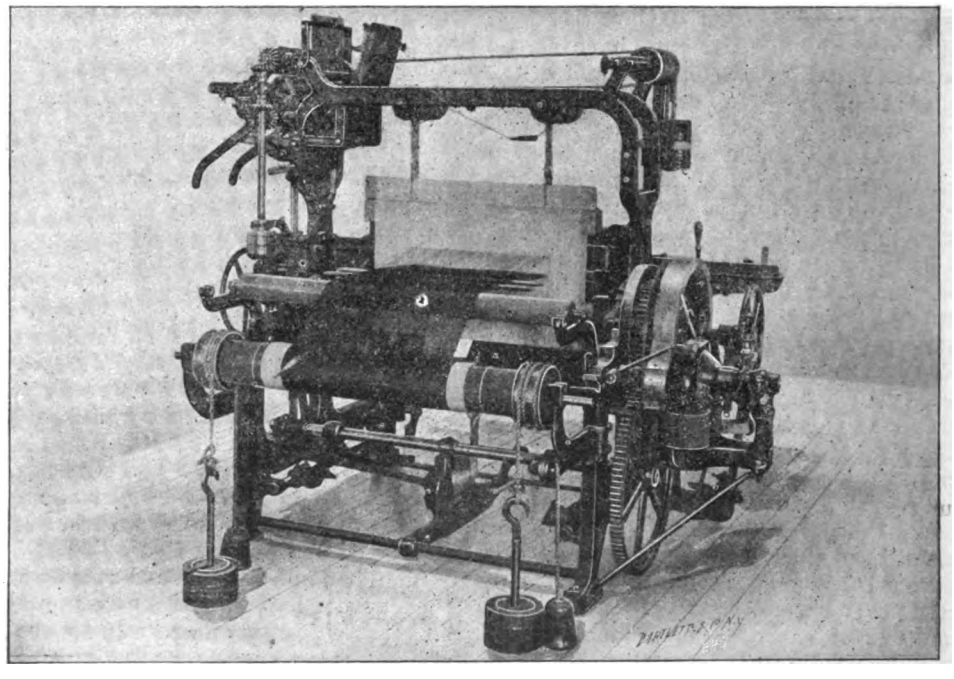
The Crocker-Wheeler Electric Company, of Ampere, N. J., equip this particular class of machinery with motors direct-connected, thereby providing for proprietors and hands the acme of convenience and a means of reaching the highest point of economy attainable. The



The Peckham Mining Truck.

above concern have shown their enterprise by installing the Western Union Telegraph Company office in Buffalo, N. Y., and in the Postal Telegraph Company's main office in New York, twenty and twenty-five dynamotors respectively, which take the place of innumerable cells of blue-stone battery formerly used.

One of the first applications of the dynamo in place of primary batteries was made in 1879 by Stephen D. Field, of San Francisco. A plant of fifteen dynamos used by



Motor On Silk Loom, In Operation, Motor At Right. Crocker-Wheeler Electric Company.

the Western Union Company in their New York station does as much work as that of thirty thousand gravity cells. By using the dynamotor, however, the regular electric-light current of one hundred and ten or two hundred and twenty volts may be sent into these machines and transformed down to the pressures used on ordinary lines, or if necessary raised to whatever potential is required. From a commercial standpoint the introduction of dynamotors marks an epoch in the history of telegraphy that speaks well for those entrusted with its present development. An immense amount of space, considerable inconvenience and much money is saved by these ingenious devices. Their universal adoption by the directors of a telegraph company at all central stations is a foregone conclusion, and it seems likely that the stock circulated by these concerns, gilt-edged as it was in the past, will harden into golden sheets in the light of this interesting departure.

MINING TRUCKS.

The mining truck is so designed that it finds its use on street railways for freight and general engineering purposes. The extension of the side frames at one end provides a platform, as seen in sketch, for the motorman, controller, brake wheel and trolley supporter. A very substantial platform built over this truck serves the purpose of carrying tools or any other machinery required for repairs, etc. This truck is manufactured by the Peckham Motor Truck & Wheel Company, and represents a most substantial and convenient accessory to street railway repair shops.

Cleveland, Tenn.—The Cleveland Electric Light & Power Company has been incorporated by W. W. Cunningham, Frank Spurlock, Foster V. Brown, John C. Ramsay and C. A. Danals. Capital stock, $10,000.

Camden, N. J.—The Union Electric Co. has been incorporated.

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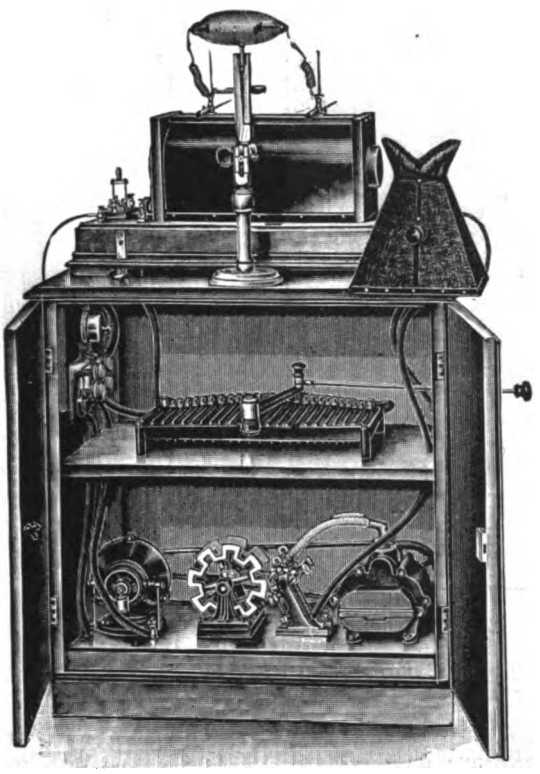
THE EDISON PORTABLE CABINET X-RAY OUTFIT.

At the beginning of the Santiago campaign the necessity of equipping the hospital ships with efficient and powerful X-ray apparatus was immediately perceived by the Surgeon-General of the United States Navy, who realized the importance of installing apparatus which should be the most powerful of its kind, and also which should be



Edison Manufacturing Co.'s Portable X-Ray Outfit.

so simple in construction and operation that it could be properly handled by any ordinary mechanic. An order was therefore placed with the Edison Manufacturing Company for one of their latest Portable Cabinet X-ray Outfits, to be placed on board the United States Hospital Ship "Solace," and the entire apparatus was placed in position ready for use within forty-eight (48) hours after the placing of the order. A brief description of this apparatus, which is illustrated below, may be of interest to our readers.

The cabinet, which is made of polished quartered oak of massive construction, occupies a floor space of two feet eight inches by one foot eight inches, and is furnished with four wrought-iron Ls screwed on to the base of same, by which it can be rigidly fastened to the deck. This is most necessary, as in case of heavy weather the apparatus might be damaged by the ship rolling if it were not firmly attached in this way.

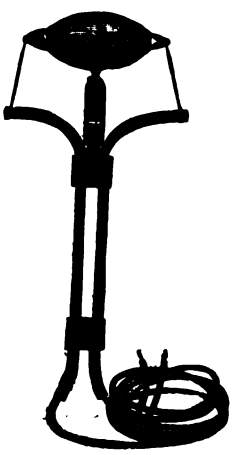
The Edison coil, which is mounted on the top of the cabinet, is also furnished with brass Ls and strips to hold it firmly in position, and the base of the adjustable focus tube stand is similarly screwed to the top of the cabinet. The upright part of the focus tube stand has a wooden screw at the end of same, by which it is attached to the base, and when the focus tube stand is not required to be used, it is only necessary to unscrew the upright from the base, which can be done in a moment.

The distinctive feature of the Edison Electric Light X-ray Outfits is, that there is no vibrator on the induction coil, its place being taken by the instantaneous air-break-wheel device shown in the bottom part of the cabinet.

This device consists of two tooth-wheels mounted on the same shaft. The projections or teeth make contact with two flat brushes which bear on the outer peripheries, and by which the current is brought in and led out again. These wheels are rotated at a very high speed, by a small direct-current motor, which also runs a pressure-blower. The air blast from this blower enters a bifurcated tube and is conducted to two flat nozzles immediately over the contact brushes.

When the device is set in operation by starting the motor and connecting the primary of the Edison X-ray coil in series with the binding posts (attached to the break-wheel) provided for this purpose, the spark formed at the contact brushes, when the coil is energized, is instantaneously blown out by the air blast at the moment of formation. This greatly increases the rapidity of change in the magnetic circuit, and consequently vastly augments the electromotive force in the secondary coil.

The controlling rheostat shown on the upper shelf of



Edison Manufact ring Co.'s Portable X-Ray Tube.

the cabinet is used to vary the current in the primary of the Edison coil, and the lever arm of the rheostat is connected to the extension rod passing through the side of the cabinet so that the doors of the cabinet can be closed and the rheostat actuated by means of this extension rod, which is shown on the right-hand side of cut. The main switch is shown on the left-hand side of cabinet, near the top, and the cut-outs directly underneath same. The advantage of this arrangement is seen at a glance, as the keys of the cabinet are always in the possession of the chief surgeon on board ship, and it is impossible for anyone to use the apparatus without his permission.

The coil is protected by a polished oak cover (not shown in the cut), which fits over the top of cabinet, and in which room is left for the fluoroscope to fit into, so that the apparatus is entirely protected when not in use. The operation of the apparatus is exceedingly simple. The focus tube is clamped in the jaws of the focus-tube stand and connected to the secondary binding posts of the Edison coil by two highly insulated thin wires.

The doors of the cabinet are now opened and the main switch is turned, which starts the motor and the pressure blower in operation. The doors of the cabinet are now shut, in order to economize space, and the reversing switch shown on the left of the coil is closed, so that the secondary current from the coil is increased by gradually drawing out the extension rod attached to the lever of the controlling rheostat.

The patient is now placed in front of the focus tube and the fluoroscope placed behind the limb or that portion of the trunk that it is desired to examine. In cases where the patient is so seriously wounded that it is necessary for him to maintain a reclining position, the focus tube is attached to the portable focus-tube holder, as shown in Cut No. 2, and the focus-tube stand is dispensed with. The ends of the portable-tube holder wires, which are very highly insulated, are now attached to the secondary binding posts of the coil. These heavily insulated connecting wires are several feet in length and the portable focus-tube holder is made of hard rubber so that it

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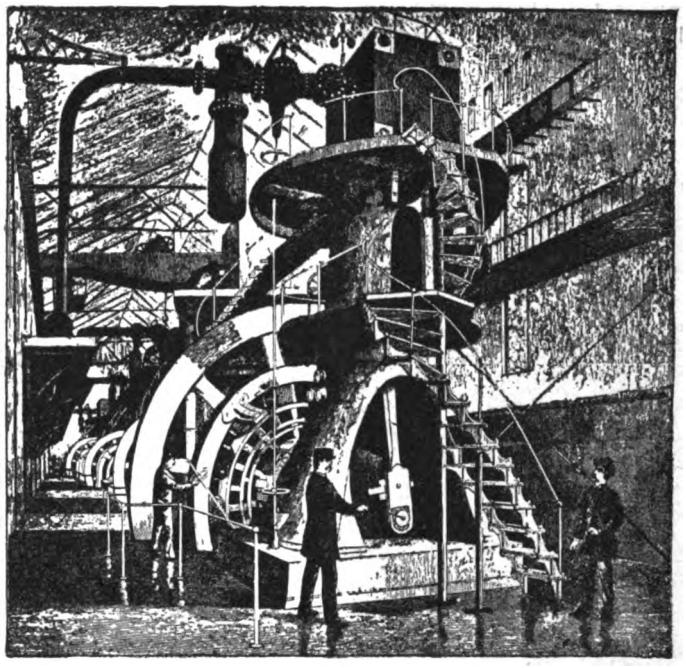
can be handled easily, without fear of shock to the operator.

The portable focus-tube holder with focus tube is now placed underneath the cot or operating table, and the surgeon makes his examination by looking through the patient from above.

"Proposed New Electric Elevated Railroad in Boston." A brief article on the proposed construction.

There are also several special contributed articles in which the reader may be interested, together with descriptions of many new improvements in electric railroading.



A Great Chicago Plant, Purely Metropolitan In Nature.

The entire apparatus is substantially and strongly made, and is also of handsome design, and the work that has already been done with it has shown the great value of such an apparatus in warfare, and the necessity of equipping all naval, marine and military hospitals with a device of this kind.

One great advantage possessed by this apparatus is that it can be moved from place to place without delay, as the cabinet is mounted on heavy casters, and it is only necessary to disconnect the attachment plug and cord attached to the main switch from the receptacle into which it may be screwed, and the cabinet may then be moved to any part of the ship or hospital and attached to another receptacle by screwing in the attachment plug, which will not occupy any time whatever.

We understand that the Edison Manufacturing Company have one of these cabinets in operation at their show rooms, St. James Building, Broadway & 26th street, New York.

REVIEWS.

The regular September number of the Street Railway Journal has been made a souvenir of the Boston Convention of the American Street Railway Association, and is, we believe, a most unusual publication in size, in typographical appearance, and in the character and quality of its reading matter. We call your special attention to the following articles:

"Street Railway Conditions and Financial Results in Metropolitan Boston." This, the leading article, is devoted to a financial analysis of thirty-one street-railway properties in and about the city of Boston. These are suburban and interurban in character, and a comparison of their financial characteristics is for various reasons of special interest to street-railway capitalists.

"The Boston Subway." In this article is described in considerable detail the latest plans of the subway stations as finally carried into effect.

THE THREE TYPES OF STATIONS.

We find on examining electric light and power stations that they are naturally divided up into what may be called

1. Metropolitan,
2. Suburban,
3. Small city or town

station. This division is all the more true when the size and utility of each power centre is considered. In any electric light or power plant it is a good thing to give the boiler plenty of room. The manufacturer will generally express his opinion very strongly on this point. The laying out of an electric light station or large power plant depends upon a few simple principles.

First, a knowledge must be obtained of the number of lights wanted or its equivalent, the horse power to be supplied. Canvassing the district will determine this. Then the dynamo, with regard to size, speed, etc., must be selected, and, finally, the engine, whether large or small. In some of our model stations found in New York the coal is on the upper floor, the dynamos below, and the engines and boilers on the ground floor. The system prevailing at present is that of having engines and dynamos directly coupled, thus saving considerable space. Direct coupling is not always the best practice in a station running arc and incandescent lights. In such a case belting is usually resorted to. In the year 1800 very large engines of the Corliss type were employed, governed entirely by the throttle valve. Today the art has so developed that regulation is automatically effected by a thorough understanding of slide-valve regulation.

In 1882 the Porter-Allen appeared, possessing features of great interest to electrical and mechanical engineers. The high-speed engine for station use is valuable because steadiness of action is secured throughout the stroke of the engine, and the small space the engine occupies is considered a great advantage in metropolitan plants. Of course, the reader will understand that the Van Vleck vertical type of engine used in the Pearl

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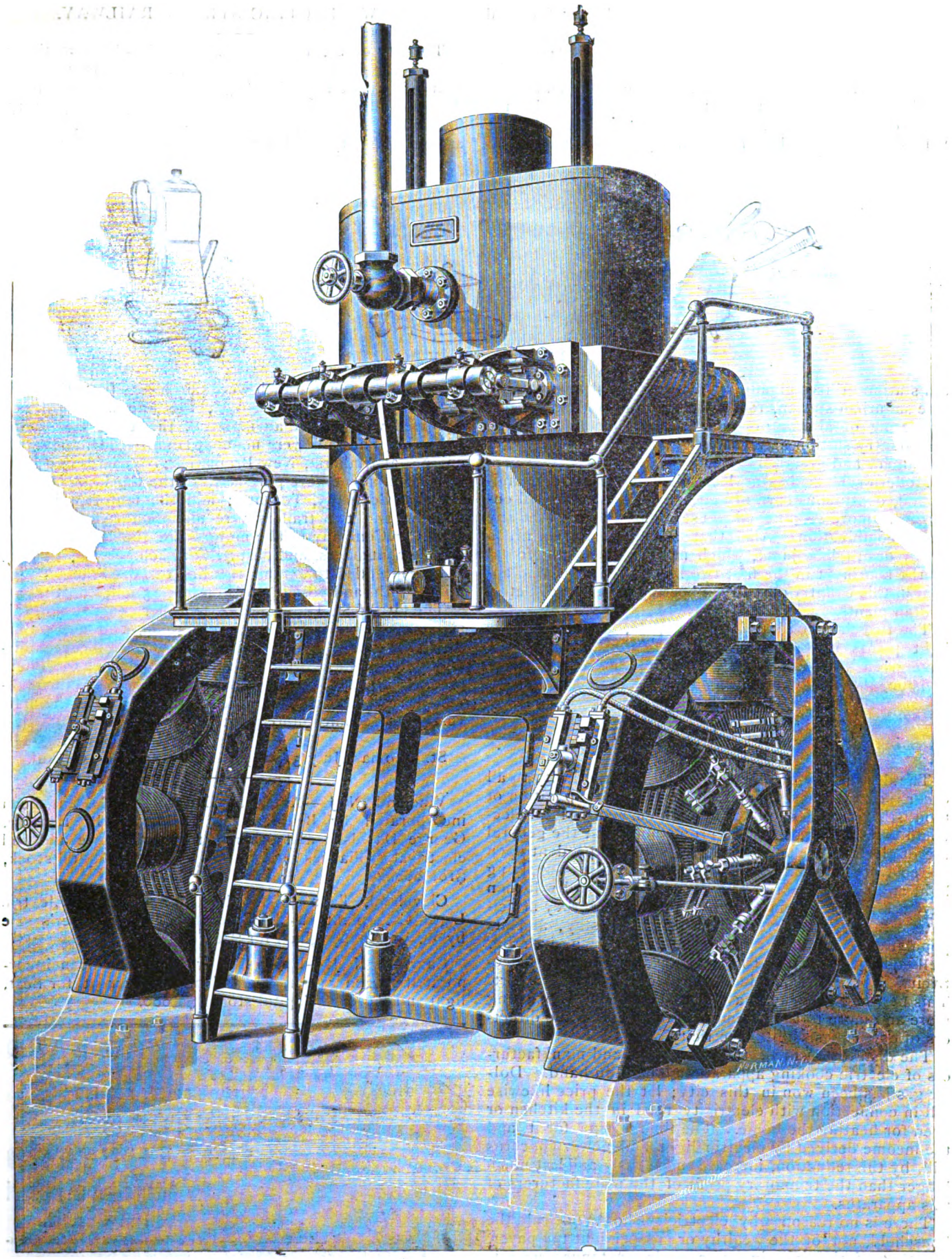

A Direct Connected Plant Occupying Little Floor Space. (See Three Types of Stations.)

street stations of the Edison Electric Illuminating Company occupy very little floor space and run at a slow speed. This company likewise used Porter-Allen engines in earlier days, but abandoned them on account of the slow action of the governor. The Armington and Sims, Buckeye, Ball and Wood, and other types of engines were introduced and worked successfully. This was attributable to the fact that their governors started instantly and

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did not overshoot, a spring being much better for good regulation than a weight in the governor.

Although these changes occurred, the difference between installations in the heart of the city, at its walls, so to speak, and in the country, became more and more marked, and gave rise to what might truly be called the three types of stations. The machinery in each of these varies in many details. In the first place, the metropolitan station utilizes gigantic generators and prime movers. The suburban station, rather hybrid type of machinery, consisting of alternators and arc-light machines, while the country station may vary slightly from this in type of machinery and greatly in size.

Modern science has at least decided that compound-wound, continuous-current generators and slow-speed engines are more economical to use in large plants than any other combination. Also that storage batteries are a highly desirable adjunct, which may frequently be found on the continent in the first two kinds of station, and appear in this country only in connection with large metropolitan plants.

The two classifications formerly made, dividing electric light plants into central stations and isolated plants, have given way to this third later and more interesting division, the metropolitan, country and suburban plant.

COOKING BY ELECTRICITY.

The desirability of electricity and its superiority to all other forms of energy as an agent for the preparation of food is beyond question. The high efficiency of all electric heating apparatus is so pronounced that the general use of electric kitchen utensils is solely dependent upon the cost of electricity. The large companies supplying light and power to city residents are having and will soon have a bigger problem to wrestle with than they anticipate. Like gas, electricity has come to stay, and its popularity is now so manifest that people living in large, well-equipped apartment houses consider the use of electricity in the kitchen indispensable to their comfort. This new and growing phase of the problem is appealing more and more to the commercial instincts of the directors of companies selling electricity.

The dual interests of these concerns and manufacturers of electric cooking apparatus go hand in hand. Dollar gas has been won in this city; let the price likewise fall in connection with electricity used in the kitchen or even for heating the home. The time is ripe for it, and the income derived by electric light and power concerns will, by this reduction, increase enormously and last much longer than the temporary profit of the manufacturers of this apparatus.

There is no reason why electricity should not rule the household, not of the wealthy or independent tax payer, but that of the man in average circumstances, who is taught to regard such an innovation at this present hour as an unseemly luxury.

Wichita Falls, Tex.—City Clerk may give information concerning contemplated establishment of electric light plant.

NEW ELECTRIC STREET RAILWAY.

The city of St. Thomas heretofore has had practically no street railway accommodations, there being in operation only about 1¼ miles of 3-foot-gauge horse-car road. A new electric trolley system was completed on June 15. The road is a belt line, 6.1 miles in length, running around the city. With the exception of the overhead joints and fixtures, which were purchased from the Ohio Brass Company, of Mansfield, the line was built and equipped with Canadian material, the total cost being $85,000. The rails were made at Hamilton, Ontario; the engines at Amherst, New Brunswick; dynamos and electrical equipment were purchased of the Canadian General Electric Company, Toronto; and the motors, eight in number, and two trailers were manufactured by the Ottawa Car Company. The motors are the latest pattern double controllers, and cost $2,800 each.

Electric Cooking Utensils.

It is intended to extend the line to Port Stanley, nine miles south, and possibly to London, 15 miles north.

The city of St. Thomas has also under construction this summer a new city hall costing $45,000, two new public schools costing $50,000, and is repaving the business district with vitrified brick instead of cedar blocks. There is a marked aspect of prosperity in all directions throughout the district, which is increasing each day as the harvest yield becomes more positively assured.

M. J. Burke,
St. Thomas, July 30, 1898. Consul.

Vineland, N. J.—American Electrocure Co. has been incorporated by Benjamin F. Ladd, Eli B. Hendee, George Davidson and others; to manufacture and sell electrical appliances for curative purposes. Capital stock, $100,000.

Cleveland, Tenn.—The Cleveland Water & Electric Light Co.'s plant has been purchased at receiver's sale by W. W. Cunnyngham for $36,500.

Camden, N. J.—Union Electric Co. has been incorporated to generate and sell electrical current for heat, light and power. Capital stock, $6,000.

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The Tribune is also particularly strong in Business News, covering the matters which every practical man must have for the successful conduct of his business.

Its great page of Open-Air Sports and Sportsmen is attracting the attention of every one. A contemporary says: "For a long time the cycling department of The Tribune has been in the hands of one of the most competent experts in the country, and its racing specialist is as well known for his picturesque language as for his accurate knowledge of horses."

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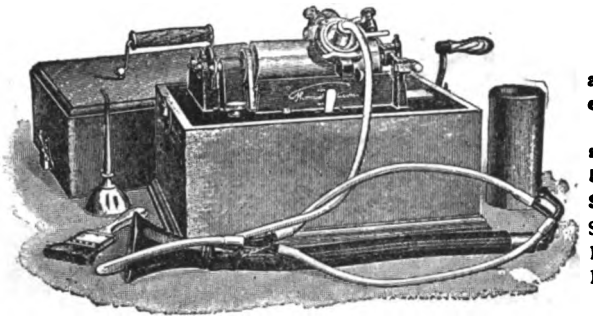

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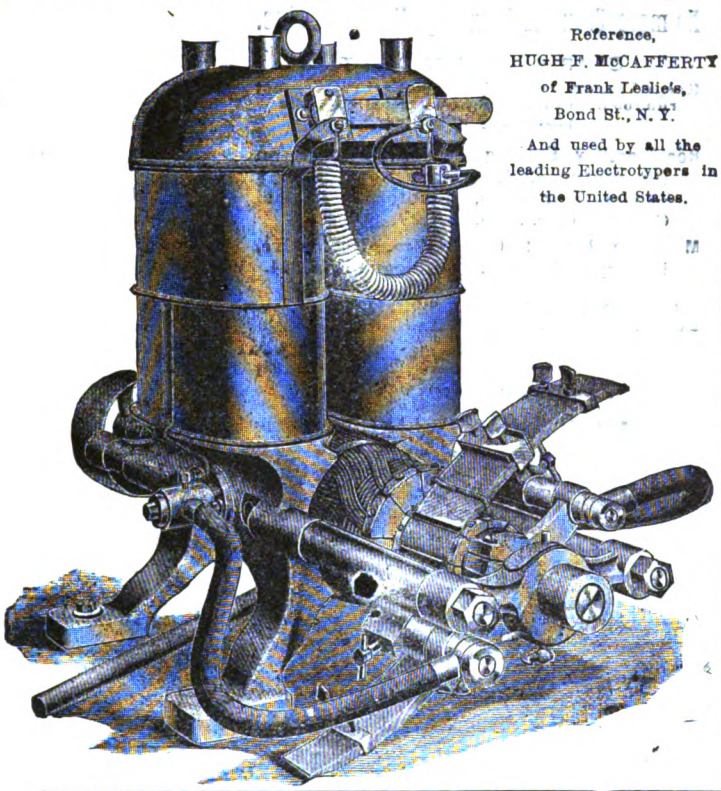

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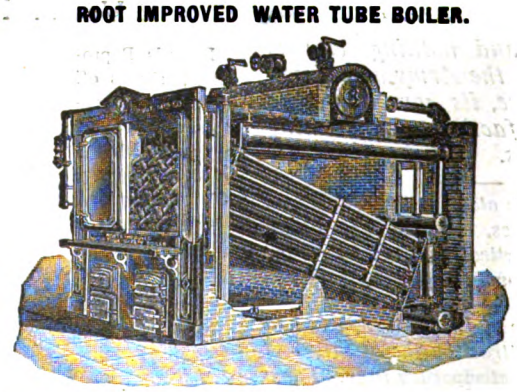

Selected by leading Electric Light Plants and Street Railway Companies throughout the United States. The following are the acknowledged requirements in water-tube boilers: *Straight tubes which can be thoroughly inspected and cleaned inside and outside; perfect suspension, allowing free movement of whole boiler expanding and contracting; perfect flexibility for the difference in expansion between upper and lower tubes; interchangeable parts, built to fixed standards; facilities for making quick and easy repairs which can be done by your own engineer or machinist; a cover joint which can easily be made tight, and frequently broken and replaced without injury; provision made to introduce the feed water where it will not chill and moisten the steam; provision made to carry feed water impurities direct to the mud drum and not past the ends of the tubes; provision made to supply the lower tubes with a bountiful supply of cool water; the use of the best materials and fittings the market can afford; the best possible workmanship; a large disengaging surface for the steam to escape from the water; small cast iron pressure parts; ample heating surface to prevent injury to parts should boiler be forced above its rating.*

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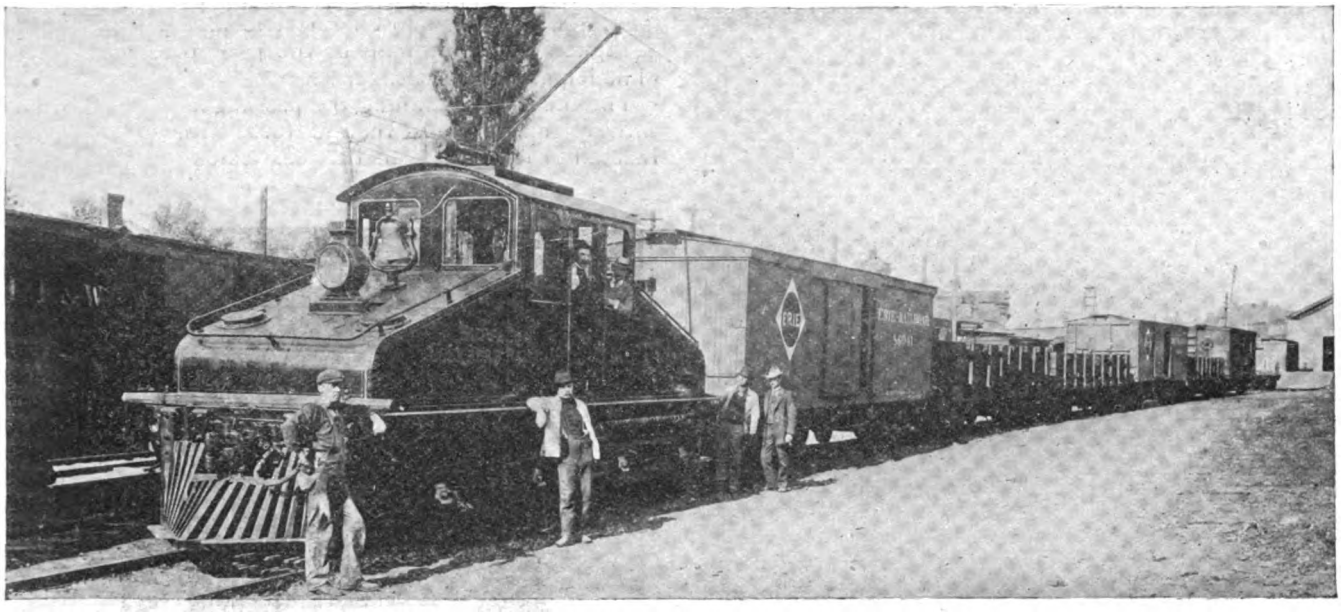
The Electrical Age.

VOL. XXII—NO. 12 NEW YORK, SEPTEMBER 17, 1898 WHOLE NO. 592



Locomotive and Train at Lockport.

THE BUFFALO & LOCKPORT ELECTRIC ROAD.

The most recent application of electricity to the steam railroad, superseding, with faster schedule, the steam locomotive and steam schedule, was made on Monday, August 15, on the branch line of the Erie Railroad which runs from Tonawanda to Lockport, N. Y., feeding into the main line of that road. The service is of a mixed type, the passenger traffic being carried on by trolley cars and the freight service by electric locomotives.

The operating company is the Buffalo & Lockport Railway Company, of which Mr. W. Caryl Ely, first vice-president of the American Street-Railway Association, is president, and Burt Van Horn, general manager of the Buffalo & Niagara Electric Railway Company, is manager. C. K. Marshall, superintendent of the Buffalo & Niagara Falls Electric Railway Company, will also be superintendent of the new company.

The Buffalo & Lockport Railway Company was organized in April, 1898, for the purpose of connecting the cities of Buffalo and Lockport, N. Y., by means of a first-class, high-speed electric railway. It has acquired by purchase the road formerly owned by the Lock City Electric Railroad Company, consisting of five and one half miles of first-class single track running through the principal streets of the city of Lockport, with its equipment for local business It has also acquired by a ninety-nine-year lease the Lockport branch of the Erie Railroad from Lockport to North Tonawanda, N. Y., consisting of 13½ miles of single track from Lockport to North Tonawanda, with side tracks and switches at way-stations and terminals. This road, when a part of the system of the New York, Lake Erie & Western Railroad was operated by four steam locomotives. The schedule gave about eight trains per day between the principal stations, and a much less number for the less important places. Passengers went through from Lockport to North Tonawanda, from which point they reached Buffalo or Niagara Falls.

The Buffalo and Lockport Railway Company has also acquired by purchase the roads formerly owned by the Buffalo, Kenmore & Tonawanda Railway Company, and by the Buffalo, Elmwood Avenue & North Tonawanda Railway Company, consisting of 7½ miles of single track between Buffalo and North Tonawanda, and one mile of single track within the city of Buffalo. By these tracks it makes connection with the tracks of the Buffalo Railway in the latter city. The total length of the tracks owned or leased by the company is twenty-nine miles.

By traffic contracts with the Buffalo Railway Co. and Buffalo and North Tonawanda Electric Railway this company thus provides a through line from all parts of Lockport to all parts of Buffalo, and also between Lockport and Niagara Falls. It will do all the freight, mail and express business of the Erie Railroad between Lockport and North Tonawanda, and will in many ways become a component part of the Erie system. The cars and trains between Buffalo and Lockport run direct to the main station of the Erie Railroad at North Tonawanda, and the sight of the steam and electric systems side by side at this point, and doing business through the same train-yard, is a novel one.

Work was commenced May 17, 1898, and at midnight on Sunday, August 14, the steam service was suspended. Nothing has since occurred to mar the perfect and punctual operation of the road on the new schedule. It is already doing a heavy business.

Power is obtained from the Niagara Falls Power Company by tapping its long-distance transmission line between Buffalo and Niagara Falls at a point between the Falls power house and the station of the Buffalo & Niagara Falls Electric Railway Co. at Tonawanda. It is carried at a pressure of 10,500 volts alternating current over the No. 0000 bare copper wires on triple petticoated insulators set on cedar poles to the rotary converter substation located in a new power house at the Lockport terminal of the old Erie branch. Here it is led into six 150 K. W. static transformers of the air-blast type, similar in construction and operation to those installed in the Niagara street power house of the Buffalo Street Railway. In these the pressure is reduced to 350 volts, and at this pressure the current passes to two rotary converters, where it is converted into continuous current at 500 volts. The rotary converters are standard General Electric six-pole, 400-K. W., 500-revolution machines. The switchboard is of the standard panel type, and consists of one high-tension panel for the high-poten-

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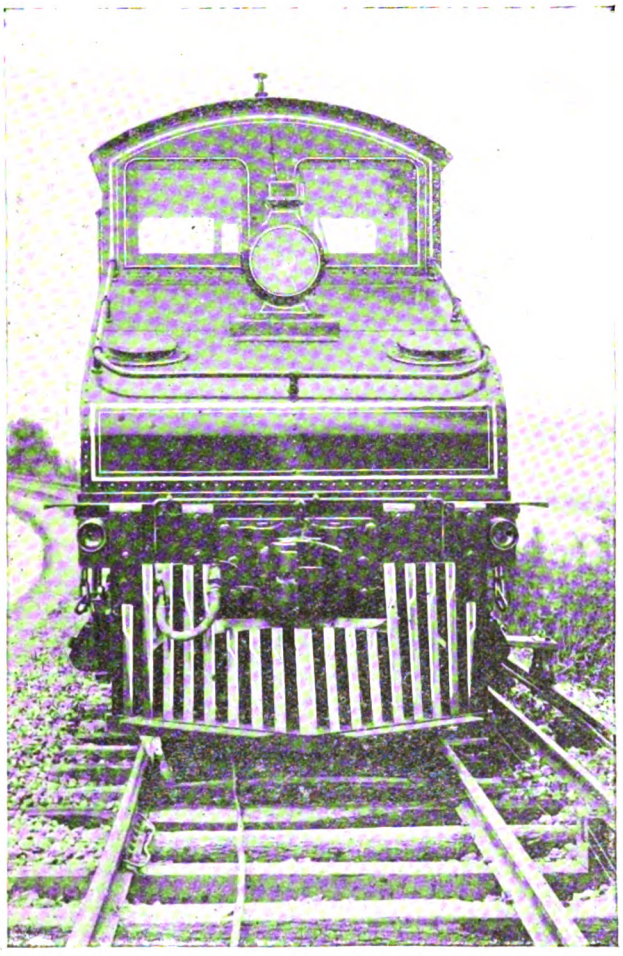
tial transmission, two low-tension panels for the alternating-current side of the rotaries, two "K" direct-current railway panels for the direct-current sides of the rotaries, and two transformer panels. The air blast for the transformers is furnished by a blower built by the Buffalo Forge Company and driven by a 1 1-2 K. W. motor.

The switches for the high-tension current are of the quick-break type, each blade being separated from its



End View of Locomotive under test at Schenectady.

next neighbor by a marble barrier. The blades are pulled open by means of a hooked stick, the hook being inserted in an eyelet into the end of the blade. The fuses on the high-potential circuits are of the expulsion type, in which the fuse is held between two springs, so that at the moment of fusing the two ends, between which the arc would ordinarily spring, are instantaneously pulled apart. Each of the direct-current panels is, of course, equipped with a "K" automatic circuit breaker.

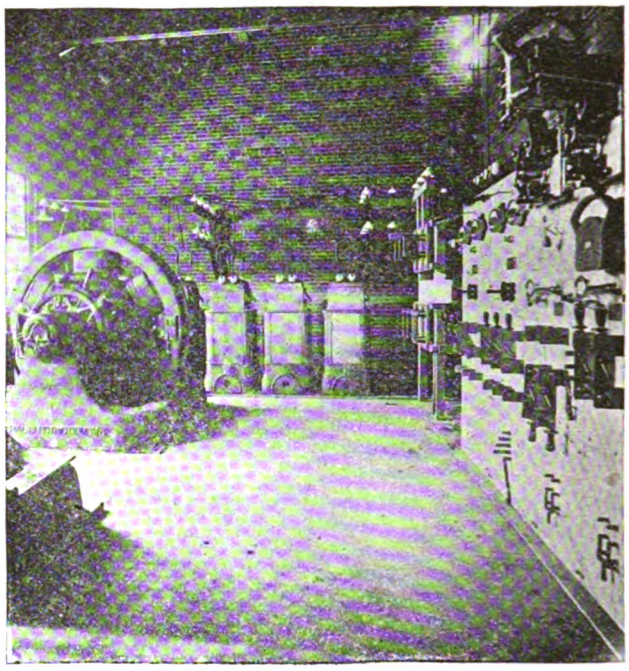
The line is protected by G. E. lightning arresters of the short-gap type, so successfully employed in the high-voltage transmission of the West, as well as on the Niagara transmission circuits. The lightning arresters are placed on the wall of the sub-station, where the high-potential transmission wires enter the building.

As soon as their present plant is completed, another rotary converter sub-station will be erected at Tonawanda, taking current also from Niagara Falls.

From the starting point in Buffalo to the city limits the cars are operated by current from the Buffalo Railway Company's station. The new converter sub-station at Tonawanda will feed seven miles to Lockport and half way in the direction of Niagara Falls, the converters at Niagara Falls feeding half way back to Tonawanda. The arrangement will be such that the Buffalo & Lockport Railway system can give current to, or take it from, the system of the Buffalo & Niagara Falls Electric Railway. The Lockport converter station will then feed back seven miles to Lockport and supply current also to the city lines in Lockport itself.

The new rolling stock consists of two 36-ton electric locomotives, supplied by the General Electric Company, for freight service, and ten electric motor cars mounted on eight weeels, and built by the J. G. Brill Company, of Philadelphia, for passenger service.

The theory of handling the passenger service has been entirely changed from that in force with steam traction. Instead of long intervals between trains, the cars are run



Interior, Sub-station, Lockport, showing Air Blast, Transformers, Rotary Converters and Switchboard.

on half-hour headway. This requires five cars to operate the twenty-five miles between Lockport and Buffalo. The speed is high. Over their own right of way the cars ran on their first trip at the rate of fifty miles per hour, including stops. The running time from Lockport to Tonawanda is twenty-six minutes; to Buffalo, one hour and fifteen minutes. In this trip thirty three minutes are spent in the city of Buffalo in a distance of six miles, where the speed has to be kept low to conform to city ordinances Even with this drawback, however, it is expected that in the near future the running time between Buffalo and Lockport will be reduced to one hour.

The pa senger and smoking combination cars are 31 ft. 8 in. long over the end panels, and with platforms 4 ft. 6 in. long, measure 42 ft. 4 in. over the buffers. The platforms are enclosed by round-end vestibules, with openings on the diagonally opposite corners of the cars. Hinged doors, which fold back against the vestibules, completely enclose the platforms when desired. Folding gates are also provided, turning back against the outside of the vestibule. The car is divided into two compartments, one of which is used for smokers and is separated from the remainder of the car by a partition having glass windows on each side of the sliding door. All the seats have spring cushions. The inside finish of the car is cherry, with chipped glass beveled edges in the ventilators. The cars are also fitted with electric heaters, a small one under each seat, and also push buttons. All the cars of the road are mounted on Perfect trucks.

These cars are run on "T"-rails at a speed that will enable them to average forty-five or fifty miles per hour. Electric brakes are provided upon each axle, the disks being cast upon the wheels themselves.

The baggage and passenger combination cars are especially adapted to high-speed service. They have a

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passenger compartment, with a seating capacity of twenty eight, and a baggage compartment. The car body is 31 ft. 8 in. long over the end panels, 7 ft. 8 in. wide at the sills, and 8 ft. wide at the widest point. The platforms are 4 ft. 6 in. long. The total length over the angle-iron buffers is 37 ft. 10 in. Cars and trucks are from the shops of the Brill Co., Philadelphia.

Each car is equipped with four G. E.-57 (52 H. P.) motors and B-8 controllers. The equipment is similar to that on the new cars used on the long-distance lines of the North Jersey Street Railway Company, of Newark, N. J. The weight of each car loaded is from twenty to twenty-five tons.

The two locomotives have been built for the purpose of handling the freight business of the road exclusively. The road being a feeder to the main Erie system, the freight traffic is considerable. To haul it, therefore, powerful locomotives were necessary, and in them the General Electric Company, which alone has had any experience in building large electric locomotives, has incorporated such improvements as the actual operation of its locomotives on the Baltimore & Ohio Railroad, the New York, New Haven & Hartford R. R. and the Hoboken Shore Road has dictated.

The design follows closely that of the locomotives just mentioned, two sloping shields being placed one on each side of a central cab, the whole carried on two swiveled trucks. The cab frame is made of 1 3-4 in. x 1 3-4 in. angles, covered with a sheathing of 1-8 in. iron.

The platform or main frame is built up of 8-in. channels running the entire length of the platform, and securely riveted to cross-plates at the ends directly over the centre truck bearings. Heavy oak buffer beams, to which are attached draw heads and pilots, are secured to the ends of the platform. The trucks have swing bolsters, supported by elliptical springs, and the truck frames are built up of forged and rolled iron securely bolted and riveted together, the pedestals being made of cast steel. The truck proper rests on coil springs, supported by equalizing bars. The wheels are 36 in. in diameter, with steel rims and iron centres.

The locomotives are each equipped with four G. E.-55 motors. The draw-bar pull at full speed is approximately 3,400 lbs., handling a 340-ton train at about fifteen miles per hour. The motors are rated each at about 160 H. P. As the maximum speed required is quite low, two motors are at all times connected in series.

The controller is of the K-24 type, with cut-out wiring modified to fit the special requirements of the equipment in regard to speed. Outside the resistance points only two combinations of the motors are possible—the first throwing all four motors in series, and the second or running position, placing motors No. 1 and No. 3 in series and the pair in multiple with motors No. 2 and No. 4, similarly connected.

The locomotives are equipped with pneumatically controlled trolleys. With this arrangement it is no longer necessary for the engineer or helper to leave the cab to replace the wheel on the wire or reverse the trolley. This is effected by a handle conveniently placed over the engineer's head. The downward motion is obtained by admission of air to a cylinder, the piston of which in moving compresses the spring holding the pole in place when running. The upward motion is accomplished by the spring and the movement sideways by hand, both pole and handle being on a swivel plate. The view of the locomotive in Fig. 2 was taken under test at Schenectady. Here, for convenience, the current was taken from a third rail, and this explains the absence of a trolley pole.

The balance of the equipment consists of air brakes, air whistle, bell, air blast sanding device, air pump, magnetic circuit breaker, magnetic switch, lightning arrester, electric lights, etc.

The following are the principal dimensions:

Length over all	32 ft.
Height of cab over rails	12 "
Distance between centre of trucks	13 "
Wheel base (one truck)	6 "
Gauge	4 " 8½ in.
Diameter of wheels	36 in.
Complete weight of loconotive	36 tons.

The locomotives have already been subjected to several severe tests. They are specified to be capable of hauling trains of 300 tons weight, exclusive of the locomotive, which, estimating the average car at thirty tons, would mean a train of ten cars. The locomotives have already proved themselves equal to hauling as many as twenty-eight loaded freight cars at the specified speed of fifteen miles an hour.

The transformation of this line from steam to an electrically operated road marks an important step in the employment of current on the steam road. If in its operation it successfully attains the results expected, it will conclusively prove that electricity can be economically applied to the operation of branches and feeders of steam trunk-line systems. It would be too much to expect an immediate conversion of these latter main lines from steam operation to operation by electricity, but with electric locomotives and motor cars profitably carrying on both freight and passenger traffic on their feeders, the entering wedge will be driven still further and the ultimate result will be by so much nearer of attainment.

Considerable satisfaction has been expressed by the citizens of Lockport at the change in motive-power, and great credit is due Messrs. Caryl Ely and Van Horn for the initiative which has brought about the successful installation of electricity on this road.

THE WILLARD THIRD-RAIL SYSTEM.

The Long Island Railroad Company have allowed Mr. Willard, the originator of the Willard third-rail system, to make a test upon a two-mile length of track, its object being to show the practical utility of the system he has developed and its superiority to those now in vogue. Mr. Willard has spent a great deal of time in perfecting the details of this system and now feels that the time has approached to give it the roughest kinds of handling. Street-railway men look forward to the results of this test with great curiosity. It may start an innovation in street-railway practice that will be regarded as distinctly progressive.

See page 169—"Electric Roads in Canada."

TWENTIETH ANNUAL CLAMBAKE OF THE AMERICAN ELECTRICAL WORKS.

The above time-honored institution is annually revived and heralded by a form of invitation reading as follows:

You are invited to be present at the Twentieth Annual Rhode Island Clam Dinner tendered to the Electrical Fraternity by Eugene F. Phillips, general manager of the American Electrical Works, of Providence, R. I., at Pomham Club, on Saturday, September 10, 1898. Lunch at 11:30. Bake opens at 2.

The good fellowship predominant at these picnics leaves a lasting impression upon the participants, making those that are invited regard themselves as among the favored few.

Council Bluffs, Iowa.—Council Bluffs Gas & Electric Light Co. has petitioned for foreclosure of first mortgage and receiver.

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THE MINING OF MICA.

FOR each known mineral a purpose has been discovered, sometimes making it of immense commercial value. The back-bone of this earth is of granite, and among the elements of its composition may be found a substance of the greatest importance to the electrical world, namely, mica. Mica mining is an ancient industry, and although the demand for mica in the days of ancient Egypt was great enough to call it to the attention of mankind, in these latter days, thousands of years after, the demand, through the influence of a new and prospering industry, has developed to enormous proportions.

There are mica mines all over the world, yet but few

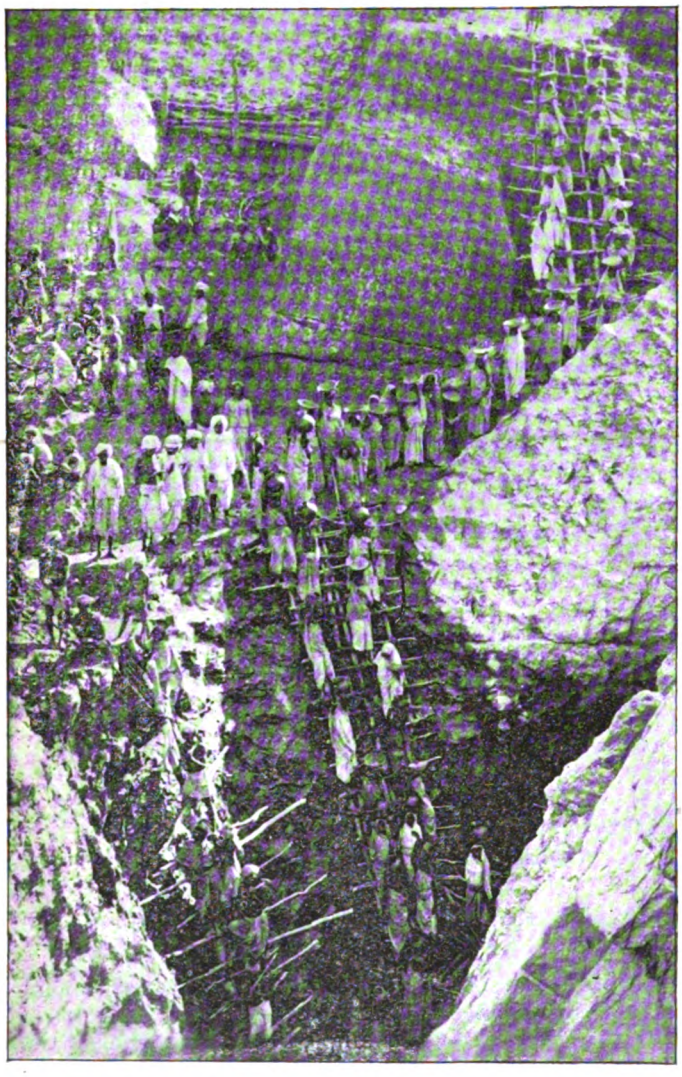

Plate 1.—Women Carrying Mica from the Mines.

of them produce that quality of mica so valuable for insulating purposes to electrical engineers. The most famous mines in the world are to be found in India, from which are obtained a pure and finely laminated quality of the highest insulating properties and most satisfactory size.

Mr. Franklin Brooks, of Eugene Munsell & Company, 218 Water street, New York City, whose specialty is that of handling mica for the trade, is one of the few Americans given an opportunity of witnessing the processes through which mica passes, from the mine, with its picturesque surroundings, to the manufacturer of electrical machinery, thousands of miles away. The primitive methods employed for its removal are illustrated in the foregoing reproduced photographs. The name of this mine is the "Abruker," which is 200 feet deep and is operated entirely by native help. Women bear the brunt of labor in removing it from the mine proper.

The discovery of the use of mica for commutator construction was brought about by a long course of practical experiments. There is no known substitute for this material but air, and in consequence every manufacturer of power machinery is forced to use mica. The insulating properties of mica have made it invaluable to the experimentalist, as well as the manufacturer. By its use when a plate is exposed to a powerful alternating electrostatic field dielectric hysteresis is perceptible if the mica has been bathed in paraffine. The specific inductive capacity of mica would make it valuable as a wire insulator in obviating many of the deficiencies of other insulating materials through which electrostatic induction readily occurs. Faraday's remarks in relation to the dielectric and insulating properties of bodies are as follows: "Glass and many bodies which might at first be considered as very fit * * * proved exceedingly unfit. Glass, principally in consequence of the alkali it contained, however well warmed and dried it may be, has a certain degree of conducting power upon its surface, dependent

Plate 2.

Cutting. Cleaning. Packing.

upon the moisture of the atmosphere." Faraday does not state anything disparaging about mica, and universal practice has shown that it stands unique among known minerals in its valuable service to electrical workers.

"The Mineral Resources of the United States," edited by David T. Day, chief of division of mining statistics and technology, which book is issued by the Department of the Interior and the U. S. Geological Survey, contains the following statement, which certainly gives great credit to Eugene Munsell & Company: "Mica is used in the manufacture of paints, wall papers, etc. Ground mica is used extensively in making lubricators and is mixed with cement. Small sheet mica is used in the manufacture of micanite for insulating purposes." It is

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evident that the manufacture of micanite by the above concern has been recognized in the literature of the U. S. Government; this, as well as micanite cloth and paper and sheets of the finest mica in the world, covers in general the list of their well-known specialties.

THE SEVENTEENTH ANNUAL MEETING OF THE AMERICAN STREET-RAILWAY ASSOCIATION HELD AT THE MASSACHUSETTS CHARITABLE MECHANIC ASSOCIATION HALL, SEPTEMBER 6–9, 1898.

President Lang, of Toledo, Ohio, called the meeting to order at eleven o'clock, a. m. and said:

Plate 3.—Bringing Raw Material From Mine.

Plate 5.—Mine Owner's Bungalow.

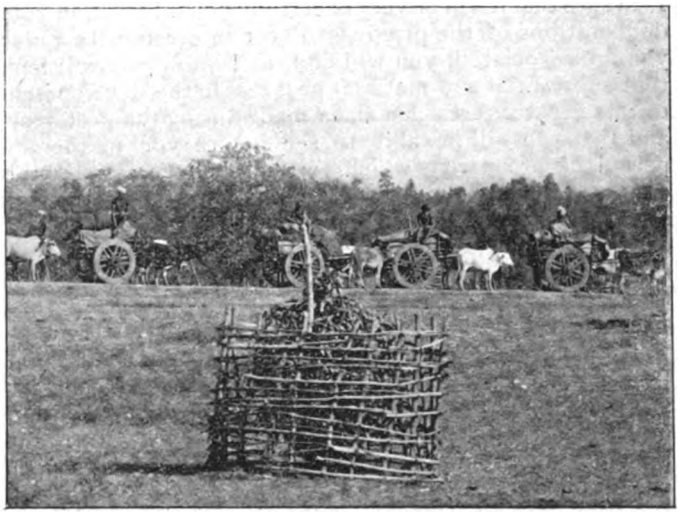

Plate 4.—Taking Finished Product to Railroad.

Ladies and Gentlemen: I have the pleasure of introducing to you Mayor Josiah Quincy, of Boston, who will deliver an address of welcome.

Mayor Quincy.

Mr. President and Gentlemen of the American Street-Railway Association: It gives me great pleasure to welcome you to the city, and to express the hope that the deliberations of this large meeting of the American Street-Railway Association may be both pleasant and profitable. The size of this gathering, the wide extent of the representation in this convention, the financial magnitude of the interests involved, affords a striking illustration of the rapid development which is taking place in the electric transportation interests of the United States. They have today won a position as one of the most important—greatest—as one of the interests of the country. Civilization really may be said to have had its inception with the first knowledge on the part of primitive men to commence some form of transportation. Civilization begins when man acquires a power of transporting himself and of transporting goods, and civilization progresses as the command of mankind over the forces of transportation, beginning with transportation in its most primitive form, increases and grows.

One great revolution occurred when mankind learned how to handle the forces of steam, and how to apply it to the great work of moving passengers and moving freights. But just as steam transportation had nearly reached its limit, just about as the means of steam transportation had been practically perfected, this new force of electricity makes its advent upon the scene, and it, too, is harnessed in its performance of the work of civilization; and instead of becoming directly, at any rate, a rival of steam, this comparatively new force of electricity finds its application, so far as transportation is concerned, upon different lines. While these lines may hereafter extend, making electricity directly a rival of steam for many of the purposes for which steam is used, up to the present time steam and electricity have divided between them two somewhat different fields of transportation; and electricity has not yet displaced steam but has filled in a vacant part of the field. It has added to the facilities of transportation which the human race has possessed, and it has supplemented in a most important respect the working of steam, which is primarily applied to transportation over long distances, to the connecting together of states and cities at a distance from each other; it has supplemented that work by the only less important work of developing the intermunicipal and infra-municipal means of communication, and I think the economic

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and social results which are to follow from the development of the electrical street railway are only second in importance to those which have followed from those of the development of the steam railroad. I think the street railway has progressed far enough in its evolution, although it has by no means filled its full field in this country, or reached the limit of its usefulness, it has progressed far enough to enable us to see that it is an important agency in the promotion of civilization.

I am confident that this street railway convention, the largest and most important, I believe, which has been held up to the present time, with its mechanical and electrical exhibits and with the important matters which are to come before it for consideration, will accomplish something for the still farther progress of this great interest and this great industry. The people of Boston are always glad to welcome these national conventions. Boston has a great electric street railway system. Not only has she one of the very greatest and, I believe, one of the very best street railroad transportation systems to be found anywhere in the world, but we have in the suburbs of Boston, in that chain of cities and towns which encircle Boston proper, which constitute Greater Boston, embracing, as it does, a million people or more within its limits, we have in these outlying cities and towns, as well, highly developed systems of suburban and inter-suburban street railway transportation. I am sure, therefore, that this Association could not have selected a better centre in which to hold its gatherings this year, in which to take account of the progress that has been made in electric street railway work during the last year, and in looking forward to the progress that is still to be made, than in this city of Boston. I can only wish that your visit may be pleasant as well as profitable, and I can only say in conclusion that if there is anything that the city of Boston, as a corporation, or the citizens of Boston individually can do to make your stay here a pleasant one, I am sure that it will be very cheerfully done. I trust, in your deliberations of the progress of the interests with which you are associated, you will find, as I know you will find, that substantial and material progress in the development of this great interest has been made during the past year; and that you will be able to see before you in the new period of prosperity which, we all believe, awaits this country during the next few years large returns in your street railway business and an inducement for the application of still further capital and still further enterprise for the still greater and more extensive development of this beneficent agency of civilization. [Applause.]

Address of President Albion E. Lang.

The American Street Railway Association. Gentlemen: We are today, for the seventeenth consecutive year, assembled in furtherance of the objects of our Association, under conditions most favorable to a pleasant and profitable meeting; for we are in the house of our father, the city of our birth.

As the presiding officer of the Association, and in the name of the street railway men of Boston, I bid you a hearty, sincere and joyous welcome.

Amid the circumstances of this meeting, our thoughts naturally turn to the time, the persons and the conditions existing when the Association was formed. Some then present are with us to-day, and, whether residents of Boston or not, certainly experience a pardonable pride in the growth and achievements of the Association, as shown by its published proceedings and emphasized by the large number in attendance.

Of the Boston people who were present at the outset, Calvin A. Richards, president of the Metropolitan Railroad Company, now a part of the Boston Elevated system, was a conspicuous and active member. In 1884 he was elected president of the Association, and those who knew him best feel a deep grief that death has robbed us of a member whose welcome, if present, would know no bounds.

As I trace the history of our Association from its inception, I am convinced that its founders, in the words of Emerson, "builded better than they knew," for is it not remarkable that they should have chosen a name and set forth in our Constitution the objects of the Association so wisely and well that no material change has been required to adapt them to present conditions, which are so radically different from those then prevailing?

The Constitution, then as now, says: "The object of this Association shall be the acquisition of experimental, statistical and scientific knowledge relating to the construction, equipment and operation of street railways," etc.

The need for experimental knowledge in connection with a mule goes without saying, and statistical and scientific knowledge with reference to harness, cars or strap-rails sounds very ancient as compared with engines, boilers, generators, girder rails, vestibuled cars, lightning arresters, ohms, volts, watts, amperes, etc., etc., the familiar subjects of to-day. I do not mean, however, to belittle the value of the investigation, discussion and association of the earlier days, because there are too many veterans present (and I might myself be called one) who can testify to the great benefit derived therefrom.

Having laid in this city the foundation of the splendid structure we have since reared, it is very proper that we should return and dwell therein for a few days. Everything gives promise of this being the largest meeting in our existence. If we do not make it one of the most valuable, the fault will be with ourselves. Let us hope to leave such an impression that the Boston people will say: "It was good to have them with us."

In the growth and development of our Association and the business we represent, let us not forget the priceless and unrivaled assistance rendered by the technical press. Without a spokesman, a guardian ever faithful to our interests as they have been, our progress would have been much slower and our pathway exceedingly rough.

Nor must we for a moment forget (if we could) the indefatigable supply man, for he is the noblest Roman of them all. It is his courage, foresight, and energy in taking up the new and useful article, and pressing it upon our attention, that helps to effect economies. We may sometimes be prematurely persuaded, but that is not the fault of the supply man; it is simply one of the arts of his trade necessary for us to learn. But seriously, without them the meetings of our Association would be materially weakened and lose much of their interest and value. Let us, then, not fail to give them and their exhibits all the attention and examination time will permit.

I desire to call attention to our fellow-workers and associates, the Accountants' Association, which hold their meetings simultaneously with ours each year, and are even now in session in another part of the building. The whole business of the street railway revolves around the accountants' office, and many of us can attest the value of having efficient persons in charge thereof. It is with the hope of enabling them to make their services more valuable to their respective companies that the Association was formed; hence they should receive every assistance it is possible for us to render. I bespeak for them your cordial co-operation.

In closing, I wish to thank our efficient secretary and the executive committee for their cordial aid and support during the year, and to assure the members of the Association of my great appreciation of the honor of being called a year ago to the office of president.

Respectfully submitted,

ALBION E. LANG.

The following gentlemen were nominated and elected by the American Street-Railway Association: for president, Charles S. Sergeant, the second vice-president of the Boston Elevated Railway Company, Boston, Mass.; for first vice-president, Henry C. Moore, president, Trenton Street Railway Company, Trenton, N. J.; for second vice-president, Ernest Woodruff, president At-

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The Electrical Age.

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AMERICAN RAILWAY TRUCKS AND APPLIANCES IN FOREIGN COUNTRIES.

The competition with American manufacturers in foreign countries has become keen within the last five years, and particularly so in connection with electric railway appliances. The consuls representing American interests abroad have repeatedly made mention of the change of the tide, through which it seems likely that American enterterprise and ingenuity will overcome the prejudices of our friends abroad to an extent sufficient to demonstrate the fact that price and quality render their goods superior. The British Government already believes in the immense advantages possessed both in skill and speed of large electric corporations supplying street-railway cars, and all that is required for their operation, over their own home manufacturers. One of the most characteristic traits of the electrical manufacturer of street railway as well as other supplies is the surprising celerity with which he turns out his machinery.

In the rating of intellects the solution of a problem is not more important than the time taken by each competitor respectively to offer a solution. In the manufacture of electrical machines and appliances the quality of the workmanship is in certain respects second to the question of time required for its production. The accepted superiority of American street-railway motors, controllers, cars and their accessories, to those made either in Germany, France or England, brings competition down to a question of the time of delivery. The tremendous headway that has been made in the United States in the field of street-railway work naturally predisposes a customer, whether foreign or otherwise, to regard our manufacturers as the best informed in the world on the subject of street railways. Therefore the introduction of American apparatus in Belgium, England, South America, Canada and even Germany and France, may be traced directly to a superior quality in design and workmanship and to a ready transportation of goods. Our latest reports indicate a growing trade with China in steel rails. This is, indeed, interesting, because it is but a question of time before Japan and China will be trolleyfied to the same extent as all the metropolitan centres in our own country.

THE STREET-RAILWAY CONVENTIONS.

Two important street-railway conventions have recently taken place. One was composed of a meeting of street-railway men from all over the United States; the other, composed mainly of delgates from New York State. The first met at Boston; the second, at Manhattan Beach. The interests represented at the first and larger convention amounted to untold millions in the line of street-railway properties. The New York State convention, though not composing as great a gathering, is still a very powerful organization. Some of its best friends and hardest workers come from Binghamton. The nature of the papers and discussions carried on at these conventions made them exceedingly valuable and very interesting to proprietors, general managers and superintendents of street-railways. No better proof could be brought forward showing an intense desire on the part of street-railway men to make rapid progress than this annual cooperation of interests and exchange of information. The general public are immediately benefited by such conventions because, taking it all in all, the object of such meetings is that of bringing about a general improvement in the systems employed. This unselfish object is certainly of benefit to those that ride in electric cars and support the huge corporations with their multitudinous nickels. The State tax upon each of these roads in itself provides our government with a very considerable annuity. These conventions, therefore, become of national importance when viewed in connection with the revenue they produce as well as convenience afforded to bread-winners.

TELEGRAPHING WITHOUT WIRES IN BELGIUM.

At Liege, Belgium, experiments have been conducted in wireless telegraphy by Dr. De La Riccia, an exponent of the Montifiore Institute of Electricity. Riccia has followed out experimentally the theory of resonance, without adherence to which idea wireless telegraphy is not truly practical. Electrical resonance is obtained by adjusting the capacity, self-induction and resistance of one circuit so that it will respond to the combined influence of these three factors in another. In other words, one circuit is electrically tuned so as to be in touch with any other properly adjusted. In practice it is exceedingly difficult to create this electrical harmony. Yet the reader can deal with the following quotation as he sees fit: "Dr. Riccia has made improvements in apparatus already in use, simplifying it and increasing its power, and claims that he can confine the oscillations of the transmitter to any special point, to the exclusion of all others. In case of communication between war vessels or ports, the message could be transmitted to one alone; in case of fog at sea, the oscillations would not be limited. Dr. Riccia, it is said, can make the presence of a vessel known to another at a distance of thirty miles, and telegraph real messages seven miles. The full text of the report has been transmitted to the War Department."

A system possessing selective power is one we have been looking for, and its successful outcome is one which will heap great credit upon earlier experimenters, such as Hertz, Helmholtz, Tesla and Pupin. A telephone system dispensing with wires may be the next invention to expect. A telephone outfit resonant to another would be the means of floating the mightiest corporation the world has ever beheld.

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lanta Consolidated Street Railway Company, Atlanta, Ga.; third vice-president, Walton H. Holmes, general manager Kansas City Railway Company, Kansas City, Mo.; for secretary and treasurer, Thos. C. Penington, treasurer, Chicago City Railway Company, Chicago, Ill.; The executive committee: Albion E. Lang, president of the Toledo Traction Company, Toledo, O.; George E. Yuill, second vice-president of the West Chicago Street-Railway Company, Chicago; Frank Jones, president of the Memphis Street Railway Company, Memphis, Tenn.; John I Beggs, general manager Milwaukee Railway & Light Company, Milwaukee, Wis.; Ira McCormick, general superintendent, Brooklyn Heights Railroad Company, Brooklyn, N. Y. It was moved and seconded:

That the next meeting of the Association be held in Chicago, Ill., provided that facilities satisfactory to the executive committee, in the way of a proper hall for exhibition and convention purposes, shall be provided without expense to the American Street-Railway Association.

Installation address of President-Elect Sergeant:

President Sergeant: Gentlemen and Members of the American Street-Railway Association: I wish to thank you most heartily for my most sudden elevation to office. I feel proud to be permitted to serve you for the coming year. I cannot hope, perhaps, to give as good an administration as my immediate predecessor, Mr. Lang, whose efforts in behalf of the association I am sure you all appreciate, and the success which has crowned these efforts, and the long line of past presidents, is one which fills the mind of a new incumbent with some embarrassment, based on the idea that there is a standard which must be upheld.

As to this association, I feel strongly that it has a great work to do, that its meetings are not merely a pleasant vacation, that it is not called together merely for the purpose of reading and discussing the papers, but I believe in the complex relations which are continually coming forward as between the communities and the municipalities and the State governments and the street railways, that much is to be gained by concerted action.

Certainly in Massachusetts we have benefitted very greatly from the fact that our street railways have pulled together for what they knew was right, and they have succeeded, after a struggle covering many years, in obtaining a settlement which, I suppose, looked at from all sides, could be called a fair settlement of the relations of the street railways and the community. I hope that the trial which is being made here of this new plan by which the oppressors of the street railways in a great many communities have been shown by an act of the Legislature how far the street railways are liable to perform work which is not in the line of street railway practice, and by which the street railways themselves are compelled to pay a portion of their receipts for the benefit of the highways—it seems to me that all this work which has been done here is instructive, and is the beginning of a proper recognition of our industry over the whole country.

I assure you, gentlemen, when I first went into the street railway business, particularly in the operating department, I was perfectly appalled; it seemed to me I was in an unlawful business, and everybody was down on the street railway, for it was hampered and troubled by one requirement and exaction after another, and when we made complaints the answer to it all was: "You are in the public streets; you encumber the streets, and you must pay for it."

How much better it is to know what we have to pay for than it is to be put to such payment that may devolve upon us in the judgment of some subordinate road department official in some municipality. I think in such ways as that, and in this matter which was taken up the other day, of the mail service, simply in having our case presented in order to get proper recognition, the association has a field perhaps greater than any it has yet filled, and I can only say in closing that so far as it lies in my power to further the work of the Association and benefit the interests of street railways, I shall certainly do so. I thank you very much, gentlemen, for the honor.

Ex-President Lang then answered: I now declare the newly elected officers to be duly installed and take pleasure in handing to the new presiding officer the gavel with my best wishes. [Applause.]

President Sergeant: I believe that the Constitution of our Association provides that the newly elected officers shall enter upon their duties after the annual meeting is adjourned. And as it seems almost as if some duties were about to be forced upon me, I suppose for that reason a motion to adjourn would be in order.

Mr. Goff, of Fall River, rose: I move you, Mr. President, that we now adjourn to meet in Chicago in 1899. The convention dispersed accordingly until a year hence.

EXHIBITORS AND ATTENDANTS AT THE SIXTEENTH ANNUAL CONVENTION OF THE STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK, AT MANHATTAN BEACH, SEPT. 13-14, 1898.

THE BIBBER-WHITE COMPANY, 49 Federal street, Boston, had on exhibition a complete line of their railway supplies, in charge of Mr. Herbert W. Smith, the manager of their railway department. The souvenirs they distributed, in the shape of a miniature trolley pole, made of aluminum, and the trolley wheel represented by a circular rubber eraser, caught the fancy of the delegates immediately and were in great demand among all.

F. H. NEWCOMB, 136 Flatbush avenue, Brooklyn, N. Y., showed a complete line of his well known uniform caps, and was ably represented in the person of Joseph Rogers.

THE NEW HAVEN CAR REGISTER COMPANY, New Haven, Conn., showed their famous "New Haven" car registers, known wherever street cars are operated. Messrs. Willis M. Anthony and A. W. Chappell represented the company and kept the attendants of the convention well informed of the merits of the "New Haven" car registers.

THE ROOKE REGISTERING COMPANY, of Peoria, Ill., exhibited the Rooke fare register, patented by George F. Rooke. This device is used for collecting fares on street cars, automatically recording them, and sounding an alarm, and is a great money saver for street railway companies. Mr. A. M. Loper was in charge of the exhibit.

THE CUTTER ELECTRICAL & MANUFACTURING COMPANY, of Philadelphia, were represented by V. C. Gilpin, their New York agent, offices 120 Liberty street. They had on exhibition their well known C-S flush switches and I-T-E automatic magnetic circuit breakers, favorably known for their never-failing accuracy and reliability.

THE DALE COMPANY, of Thames and Greenwich streets, New York, showed their new porcelain multiple receptacle for incandescent lamps. This receptacle is an unequalled car fixture, requiring no insulating joints, bugs, wiring, shade holders, and the many other requirements found in most car fixtures.

WILSON, THOMSON & COMPANY, 313-315 Fulton street, Brooklyn, had the Wilson patent trolley pole catcher on exhibition, which attracted the attention of all the visitors. This novel device catches the pole instantly after the wheel has left the wire, holding

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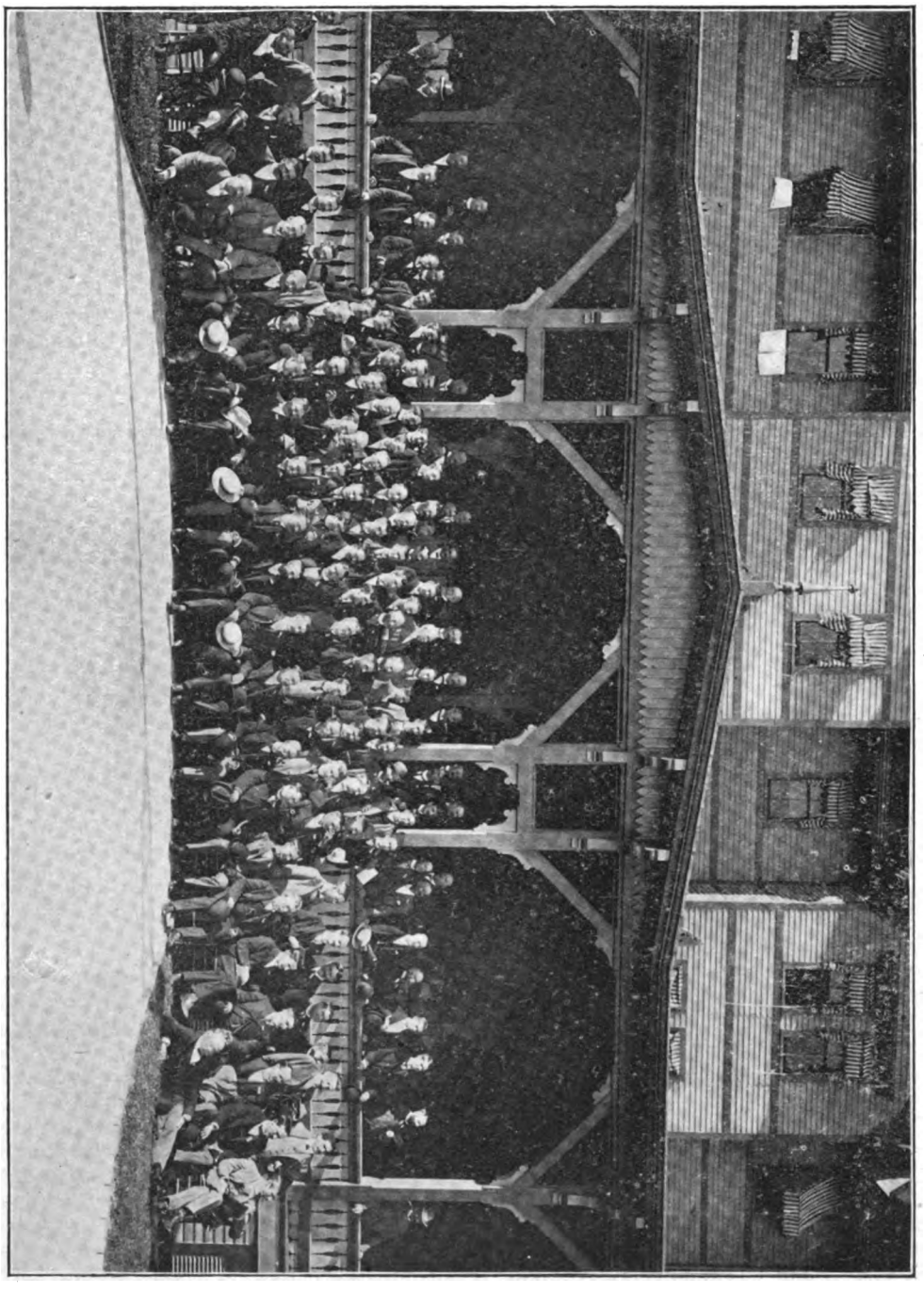
it securely until released by the conductor, and preventing damage to overhead wires. Mr. W. J. Thomson was in attendance, explaining the excellent features of the above-mentioned device.

MESSRS. J. BARKER CARTER, president, and W. O. CLARK, chief engineer, of the Indestructible Road-Bed Construction Company, 81 New street, New York, distributed circulars calling attention to the company's new system of construction of railroad beds.

exhibition samples of their work, the advantages of which were clearly explained by Mr. W. J. Walker.

THE FALK MANUFACTURING COMPANY's exhibit consisted of the automotoneer, which attracted a great deal of interest. Mr. James T. George explained to the delegates how this apparatus saved power, prevented injury to insulation, cut down operating expenses, etc., and how advantageous it was to use the same on all electric street railways.



Members of the New York State Street Railway Association.

GEORGE A. PARMENTIER, Cambridgeport, Mass., had an interesting exhibit of his life guards and track cleaners. A section of the platform of an electric car, with fender attached, was shown, thus affording an excellent opportunity to street railway men to see how this car fender is operated. The fender is meeting with great success wherever introduced, and Mr. Parmentier has received some very flattering testimonials regarding the same.

J. P. SJOBERG & COMPANY, 145-147 11th avenue, New York, manufacturers of street car woodwork, had on

GILES S. ATCHISON, 18 Broadaway, New York, representing the St. Louis Register Company, The Hunter Illuminated Car-Sign Company and manager of the Eastern department of street railways of the Hildreth Varnish Company, had an exhibition of the various lines which he represents and welcomed his many friends among the street-railway delegates, with whom he is exceedingly popular.

THE WALKER COMPANY, manufacturers of street-railway apparatus, of Cleveland, O., was well represented in the person of Mr. John D. Moore, 20-22 Broad

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street, New York. He was in charge of the Walker exhibit, consisting of various types of street-car controllers, generating apparatus and their various other manufactures used in street-railway installations.

W. PRESTON, 859 Fulton street, Brooklyn, exhibited his mechanical switch, an ingenious device used in railroad work.

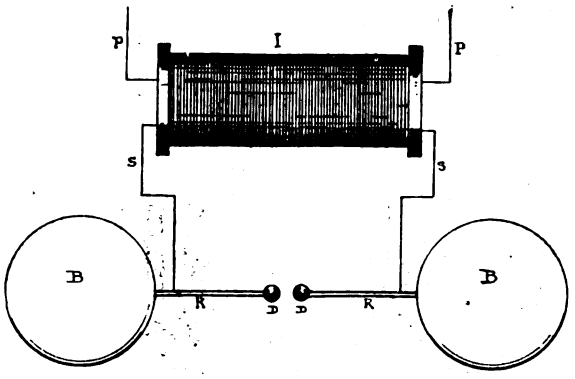
LOUIS E. ROBERT, president of the Catskill Electric Railway Company, was in attendance at the convention, and took a good deal of interest in the various exhibits.

KORAN SUGAHARA, M. E., chief engineer of the Kobu Railway Company and the Buso Chuo Railway Company of Tokyo, Japan, imparted an oriental air to the convention and was greatly interested in the work of the Yankee street-railway men.

TESLA AND HERTZ EFFECTS.

The currents of high frequency used by Tesla in his researches are produced by electrical rather than mechanical means. The alternating current dynamo used by him renders a current of 10,000 alternations per second, but the actual current necessary to the performance of the luminous effects has a frequency of millions of oscillations per second, produced by the discharge of Leyden jars or condensers.

Dr. Oliver J. Lodge, in his "Modern Views of Electricity," shows that the discharge of the Leyden jar is in



Hertz Electric Resonator.

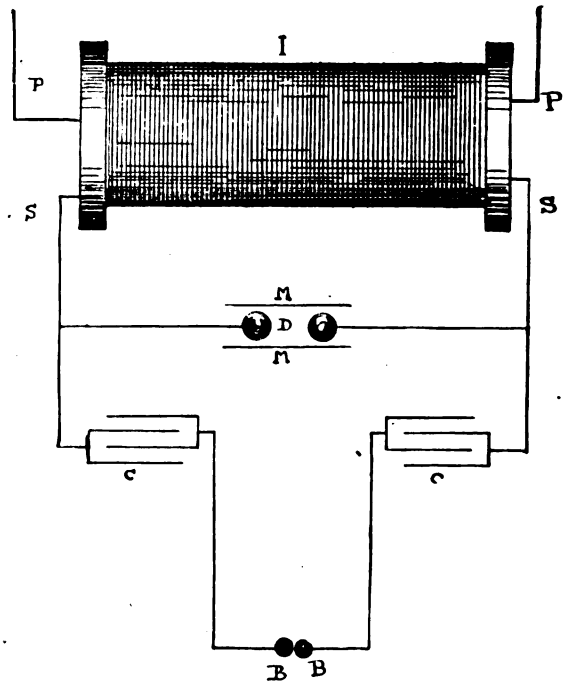
general oscillatory; the apparently single and momentary spark, when analyzed in a very rapidly rotating mirror, is shown to consist of a series of alternating flashes, rapidly succeeding one another and lasting individually less than one hundred thousandth of a second. The capacity of the condenser and inertia of the circuit regulate the rapidity of these oscillations. A 1 microfarad condenser discharging through a coil of large self-induction, such as one having an iron core, may oscillate only a few hundred times per second. On the other hand, a Leyden jar of the 1-pint size discharging through a short circuit will set up oscillations, perhaps ten million per second; and a still smaller jar would give oscillations away up in the billions. But these small jars are quickly discharged, and require a constant replenishing.

The discharge actually consists of a principal discharge in one direction, and then several reflex actions back and forth, becoming feebler until their cessation. In their vibration they generate waves in the surrounding medium, similar in many respects to sound waves, but of infinitely higher velocity. Their length depends on the rate of vibration of the source and their velocity. The microfarad discharge before mentioned will have a wave length of perhaps 1,200 miles, the small jar not over 70 feet; and yet the true light wave has only an average length of one fifty thousandth of one inch. These waves travel into space until they either die out from exhaustion or are absorbed by some suitable body; but they possess the quality of resonance in a degree like those of sound. Two tuning forks of the same pitch will influence one another—that is, one on being vibrated will start the other in vibration, even at a considerable distance, but the electric waves far surpass them in this respect.

Dr. Hertz made the first practical experiments in this direction with his electric resonator (Fig. 51). This apparatus consisted of a 3-inch spark induction coil, *I*, the secondary wires *S S* being connected to the copper rods *R R*, provided with metal balls *B B*, nearly 11 inches in diameter. The discharging balls *D D* were approximated until a satisfactory discharge passed between them. A large wire ring having a spark gap in its circuit was so influenced by the resonance as to show minute sparks passing across this gap, even when the ring was situated in a distant room. In many experiments with a rapidly vibrating induction coil current, a sparking has been noticed in metallic objects in the same room, in one instance it being discovered in the metallic designs on a wall-paper.

The "Tesla" Effects.

In exploring the comparatively new field opened up by Professor Crookes, Nikola Tesla has stimulated research



Tesla Arrangement with a Ruhmkorff Coil.

into the mysteries of high tension and frequency currents and their effects. In the majority of his experiments Tesla uses alternating currents generated by machinery of his own design, but in a large number of cases his effects can be duplicated with an induction coil suitably energized. In the latter case the apparatus consists of a battery, a Ruhmkorff coil, two condensers, and a second specially constructed induction or disruptive coil, with some few subsidiary implements. The contact-breaker or rheotome must be one giving interruptions of very rapid sequence.

Fig. 52 shows a diagram of the Tesla arrangement with a Ruhmkorff coil. The terminals of the secondary coil of the Ruhmkorff coil *I* terminate at the condensers *C. C.* Bridged across the wires before they reach the condensers is the discharger *D.* The second terminals of the condensers are led through the split primary of the disruptive coil, terminating at the points *B B* of the second discharger. The secondary of the disruptive coil is either outside or inside the primary coil. The condensers are of special design, being small, but of high insulation. They each consist of two plates of metal a few inches

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square immersed in oil and arranged so they can be brought nearer together or further apart, as necessary. Within limits, the smaller these plates are the more frequent will be the oscillations of their discharge. They also fulfil another purpose; they help nullify the high self-induction of the secondary coil by adding capacity to it.

The discharger tips are preferably metal balls under 1 inch in diameter. Tesla uses various forms of dischargers, but for experimental purposes the two metal balls will answer. They are adjusted when the whole apparatus is working according to the results desired. The mica plates serve to establish an air current up through the gap, making the discharge more abrupt, an air blast being also used at times for the furtherance of this object. The device (Fig. 53)consists of an electro-magnet, *C*, set with its poles *P* across the air gap, helping to wipe out the spark, as in a well-known form of lightning arrester. This form, described by Tesla, has the pole pieces *P* shielded by mica plates *M* to prevent the sparks jumping into the magnets. Fig. 53 is an elevation and Fig. 54 a plan of this device. The terminals from the condenser are led to the primary of the disruptive coil, or, as in Fig. 52, to two discharger balls *B B*. The disruptive coil (Fig. 55) is easily made, and will give good results with careful handling.

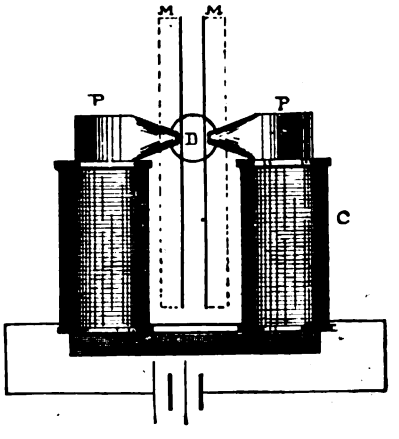


Fig. 53—Tesla's Spark Destroyer.

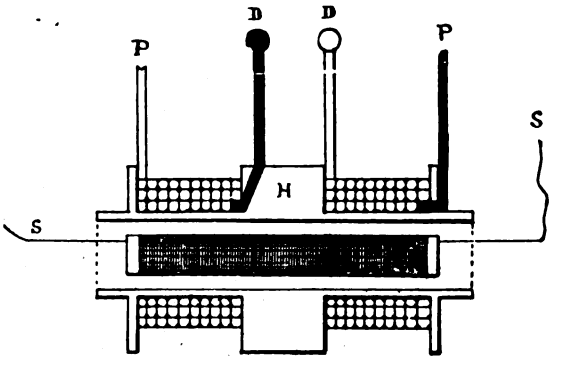
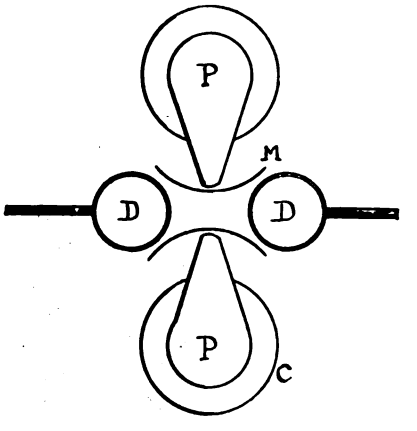


Fig. 55—Disruptive Coil.



Tesla's Spark Destroyer Shielded by Mica Plates, M M.

The secondary coil *S* of 300 turns of No. 30 silk-covered magnet wire, wound on a rubber tube or rod ½ inch in diameter, with the ends brought out in glass or rubber tubes. The primary coils are wound on a second rubber tube, *H*, at least 1-10 inch thick, and large enough inside to slip easily over the secondary coil S. It must be long enough to project 2 or 3 inches over the ends of the secondary coil turns. The primary has 50 turns in each coil of No. 18 B. & S. gutta-percha covered wire. The four ends, *P P P P*, of this coil are brought out in rubber or glass tubes, two to the condenser and two to the discharger *D D*. Each layer of these coils must be separated by rubber cloth or even cotton cloth. The further apart the layers the less the inductive effect, but the better the insulation. The whole coil is immersed in a glass or wooden vessel containing boiled-out linseed or petroleum oil. A perfect coil should have all the air bubbles drawn out of it after being immersed by putting it under an air-pump, but for many experimental uses this is not absolutely necessary; but extreme care must be taken to insulate the coils and their terminals. This will be apparent when the current is turned on.

The resonance effects obtained during the operation of a Tesla coil are very marked, and their study may lead to the solution of the problems of communication between distant points without the use of other conducting media than the atmosphere. But the main use to which the Tesla currents have been put is that of artificial illumination. These currents have enabled experimenters to obtain a high luminosity in vacua by the aid of only one conducting wire—in fact, in some cases without the utilization of any conductor than the air. An ordinary incandescent lamp connected to one terminal of the coil will show in a fair degree some of the luminescent phenomena. The brush effects from the terminals of the secondary coils are extremely marked and interesting; but to detail the experiments that can be performed with the Tesla disruptive coil would be an impossibility here. Reference is recommended to the published works of Nikila Tesla, which, happily, are readily procurable.

These currents of high frequency have of late been turned to account in electro-therapeutics, principally for the stimulation they exert on the nutritive process. They also exert a very great influence on the vasomotor centres, as is evidenced by the reddening of the skin and exudation of perspiration. This result is readily obtainable by placing the patient in connection with one electrode on an insulating stool, and terminating the other electrode at a large metal plate situated a few feet distant; or the patient may be surrounded by a coil of wire in connection with the coil of sufficient diameter, however, to prevent contact.—H. S. Norrie, in "Ruhmkorff Induction Coils," by permission of Spon & Chamberlain.

COMBINATION OF THE WALKER AND WESTINGHOUSE INTERESTS.

Two of the largest manufacturing concerns in this country, the Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., and the Walker Company, of Cleveland, O., have combined and formed what is probably the largest electrical combination in the world. The Walker Company has been very successful in obtaining large contracts for electric railway installations, but has been greatly hampered by litigation with the Westinghouse Company. The combination, therefore, of the two corporations will result in their working on a more profitable basis than heretofore, unhampered by ruinous competition.

TELEPHONE CALLS.

New Orleans, La.—T. F. Ahern, superintendent People's Telephone Co., is making arrangements for the establishment of a telephone system in New Orleans.

Magnolia, Miss.—The Citizen's Telephone Co. has been granted a franchise by the mayor to build, erect and maintain a local and long-distance telephone system.

Macogdoches, Texas. — Telephone connection with Shreveport, La., will soon be established, the work being pushed as rapidly as possible.

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TELEPHONES AND TELEPHONE EQUIPMENTS.

One of the most remarkable industrial developments in this country and abroad is to be found in the manufacture of telephones and telephone equipments. There are thousands of cases on record where the use of the telephone was not even suggested until a full knowledge of its practical utility made a place for it and showed its immediate application.

De Veau & Company, of 27 Rose street, New York City, have covered the field in full and produce, for the trade and individuals, telephone systems and their accessories of a thoroughly modern construction. This concern was organized in 1892 and have added to their reputation ever since as builders of high-class telephone apparatus. To show the extent of their enterprise we need only refer to the submarine telephone used by the United States Government in connection with the diving costumes supplied to the men of the Light House Board and the United States cruisers and battleships. The portable marine and field telephone outfits for army and navy work have met with great success.

The egg 'phone, illustrated in these columns, is exceedingly convenient where suspension is required from ceiling, wall or gas brackets. It is the smallest and best telephone, as well as the most convenient, in existence, comprising receiver, transmitter, and ringing key. The armored set is so constructed that it represents a most practical telephone outfit, composed of transmitter, receiver and electric bell signal, instead of magneto. The monitor armored set, as well as the armored set just referred to, individually require two cells of batteries for ringing and talking. These 'phones have met with the approval of the trade and consumers to such an extent that the names of certain standard outfits have become by-words. The intercommunicating telephone installed and constructed for any number of stations has proven quite a success in factories, hospitals, large private residences and office buildings. The flexibility of this system and its smoothness of operation have won commendation for it wherever installed. The owners of country villas have found it particularly useful in enabling them to be put in instant communication with any of the outhouses or employees on the premises.

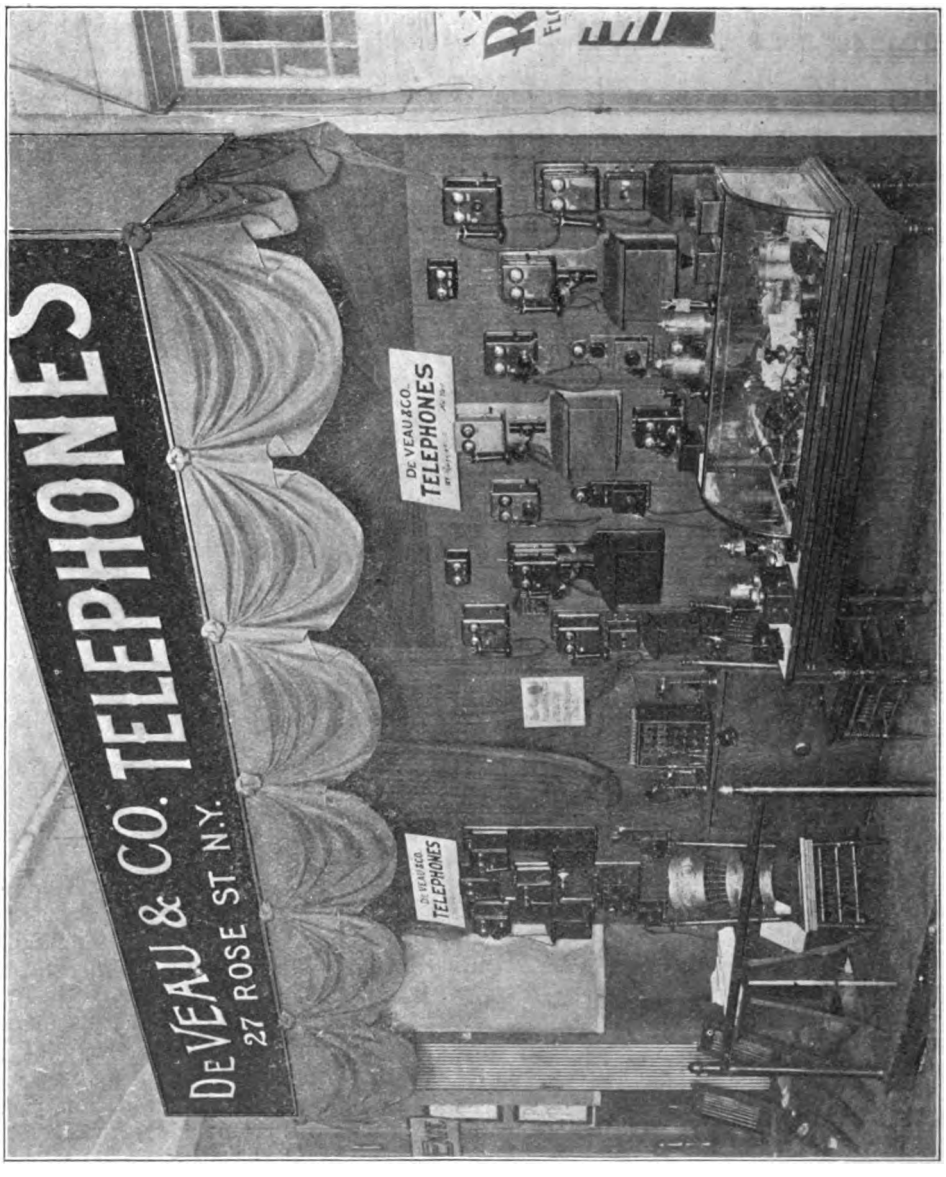

Exhibit of De Veau & Co.—The Latest Telephone and Telephone Appliances.

The long-lever automatic switch, as well as the self-contained switch, manufactured by De Veau & Company, appeal most strongly to the contractor, its technical value, as well as practical importance, making it indispensable to him when completing a contract that is supposed to be self-contained and to comply in every detail with a liberal form of specification.

The sneak-current lightning arrester, for the purpose of protecting telephone apparatus from sneak currents, lightning or short circuits, is represented for the reader's benefit ready for use. The advantage of this protected device is only appreciated by its absence. In many cases where accidents have occurred, due to the three causes mentioned, and considerable damage caused to telephone

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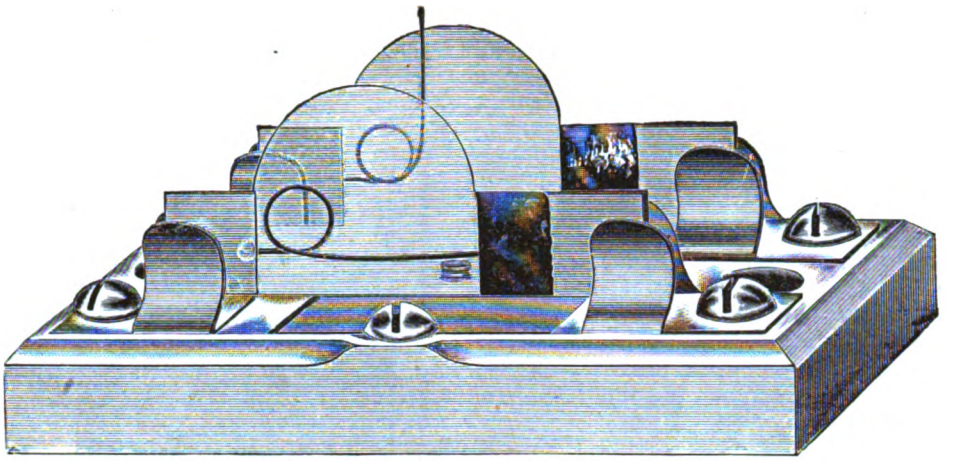
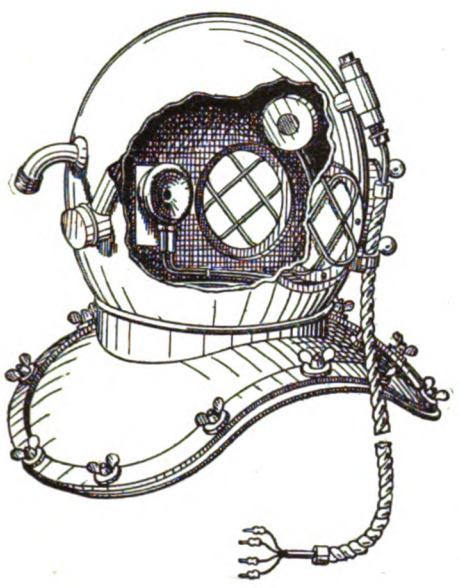
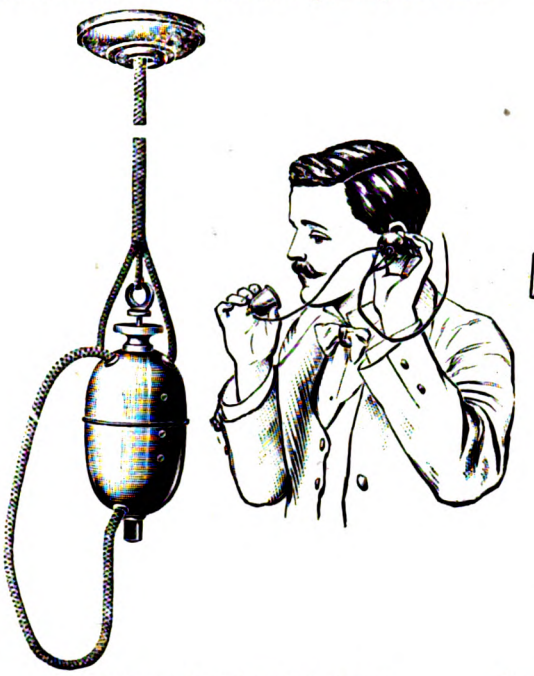


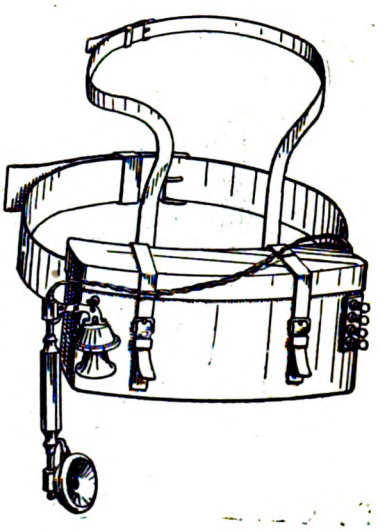
De Veau & Co.'s Sneak Current Lightning Arrester.



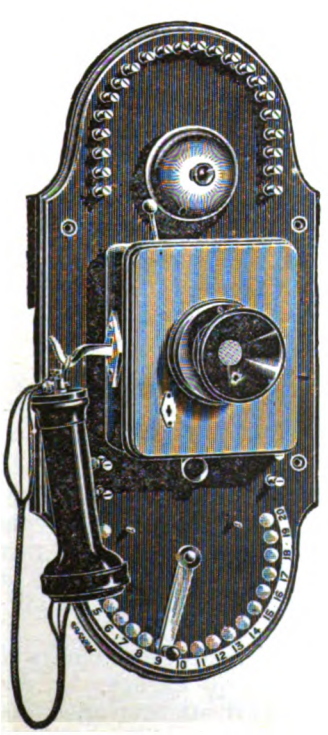
De Veau & Co.'s Submarine Telephone.



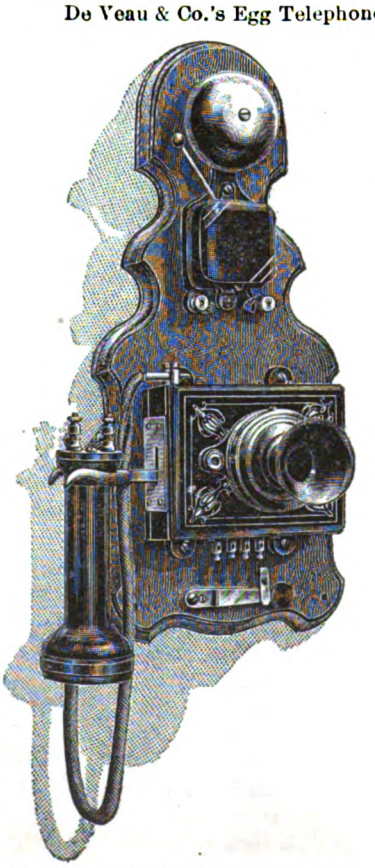
De Veau & Co.'s Egg Telephone.



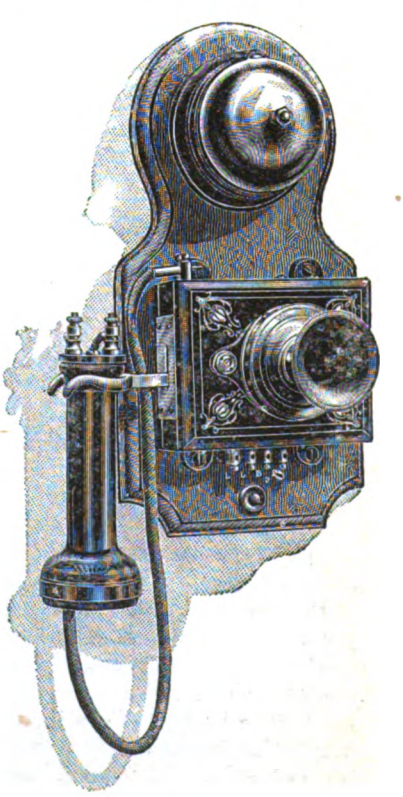
De Veau & Co.'s Submarine Telephone.



De Veau & Co.'s Monitor-Armored Set



De Veau & Co.'s Intercommunicating Telephone.



De Veau & Co.'s Armored Set.

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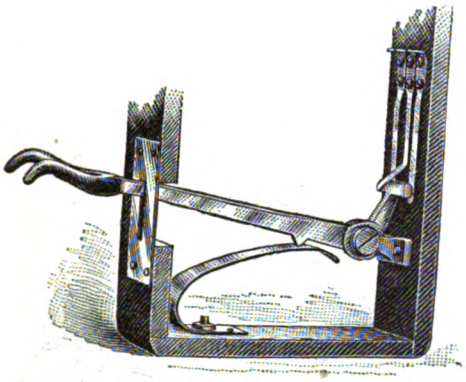
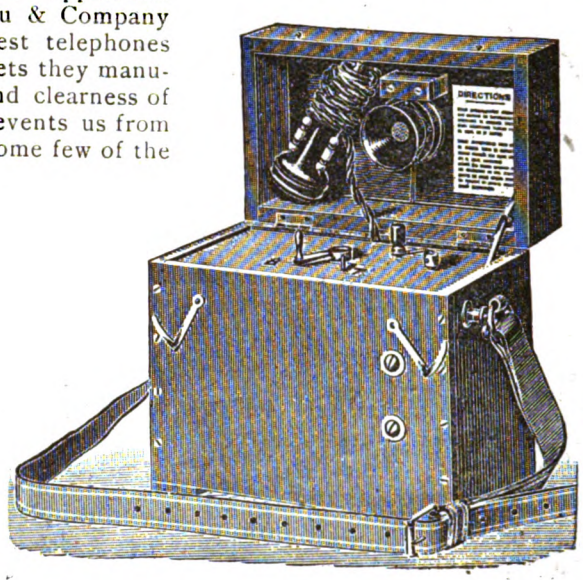
apparatus, the use of De Veau & Company's sneak-current lightning arrester, by preventing this loss, would have saved much embarrassment in time and money resulting from same.

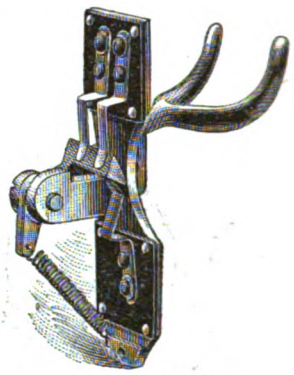
The fully equipped factory of De Veau & Company enables them to cover the telephone field so completely that customers and contractors are invariably satisfied by calling upon them for the purpose of obtaining durable, handsome and well operating telephonic apparatus. Having kept abreast of the times, De Veau & Company are fully prepared to supply the very latest telephones and telephone equipments. The cabinet sets they manufacture rival all others in design, finish and clearness of tone. The great scope of their work prevents us from making more than a passing reference to some few of the specialties they manufacture.



De Veau & Co.'s Long Lever Automatic Switch.



De Veau & Co.'s Portable Marine and Field Telephone.

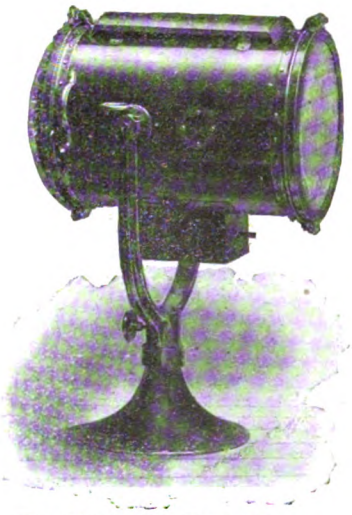


Self-Contained Switch.

THE MANHATTAN PROJECTOR.

The following illustration shows a type of projector or search-light manufactured by the Manhattan General Construction Company, of 11 Broadway, New York City. It is used on sailing craft such as yachts and steamships. From a mechanical standpoint the projector is exceedingly compact, the lamp mechanism being contained below the projector in a box-shaped receptacle. By this means shadows are absent and the light streams forward unaffected. By using horizontally fed carbons which may be moved to any position great convenience is obtained. By the use of English mirrors a vessel a mile distant is clearly distinguished. As the beam can be thrown vertically as well as horizontally, signaling can be carried on in foggy weather.

This substitution of projectors for search-lights means the substitution of a mirror for a silvered coppered parabolic reflector. For naval work, freight and pleasure craft, the projector occupies a very important position, its use in this field of work being almost indispensible and the adoption of this modern contrivance for advertising purposes incalculable. The projectors are made in japanned iron or polished brass, with copper trimmings, and the eight, fourteen and eighteen-inch sizes in aluminum.



The Manhattan Projector.

WHAT FOREIGNERS THINK OF OUR RAILWAYS.

What a few foreigners have said of American railways may be of interest:

Li Hung Chang, the great viceroy of China, said: "Nowhere else in the world are there such fast and luxurious trains" as in America.

Marquis Yamagata, field marshal of the Japanese Empire, said: "The speed, the comfort, the luxury of your railroads, is a marvel to me."

Prince Hilkoff, imperial minister of railroads of Russia, said: "There is nothing in Europe to compare with your railroads."

Sir Henry Truman Wood, special representative of the British government to the world's fair in 1893, said that "nowhere in Europe could there be found such luxury in travel and such excellent service as are given on the railways of the United States."

Paul Leroy Beaulieu, one of the greatest economists of Europe, writes: "The continent of Europe, by the bonds in which it has always held private enterprise, has been able to follow only with a tardy step the example of the United States, which nation has realized in its railroad system three ideal conditions, rapidity, efficiency,

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and a good market, while Europe, enveloped in administrative formalism, was destined to attain neither of these three conditions."

ELECTRIC RAILWAYS IN CANADA.

St. Catherines, Ont.—It is believed that the deal for the purchase of the Niagara Central Railway by an American syndicate will be concluded. Messrs. Loss, of Buffalo, and Gibbs, of New York, representatives of the syndicate, were here recently, investigating the outlook of converting the road into an electric system and extending it to Port Dalhousie and Beamsville.

Toronto, Ont.—The Metropolitan Street Railway Co. are considering the extension of their line to Schomberg.

Winnipeg, Man.—A local company has announced its intention to utilize a part of the water power from the Winnipeg River. The project includes the building of an electric railway to extend from the mouth of the Whitemouth River to points on the Winnipeg River.

Lanark, Ont.—The ratepayers of Perth have defeated the Lanark County Electric Railway bonus by-law. There is now a scheme on foot to connect this town with Carleton Place.

Montreal, Que.—The Montreal Street Railway will put down new rails on Craig street.

Nelson, B. C.—C. S. Drummond will apply to the city council for a charter for electric street railways to be built in the towns in this vicinity. Mr. Drummond represents the British Electric Traction Company, of London, England.

Paris, Ont.—A deputation of Toronto gentlemen have approached the Council on the subject of the construction of an electric railway between this town and Ayr. It is understood that a charter has been applied for.

Ottawa, Ont.—The Ottawa Electric Railway Co. intends, it is reported, to extend their line to Britannia. It is also rumored that a bridge will be built across to Aylmer.

Paris, Ont.—A company is seeking a charter under the name of the Grand River Electric Light and Power Co. to construct a stone dam across the river at Mr. Cavan's farm, with the object of supplying light and power. Mr. Fair, of Brantford, is the company's engineer.

CANADIAN ELECTRICAL NEWS.

London, Ont.—An effort is being made to organize a new telephone company. A number of local capitalists are interested.

Brantford, Ont.—The Brantford Electric and Operating Company will expend $10,000 in putting in a new plant, having received the contract for street lighting for ten years.

St. Thomas, Ont.—The City Council has appointed a committee to report on the question of establishing a municipal electrical plant for street lighting and commercial purposes.

Portage La Prairie, Man.—The Central Electric Light Co. contemplate installing a telephone exchange.

Barrie, Ont.—The Electric Light and Waterworks Committee has reported in favor of installing a municipal lighting plant and recommends that a vote of the ratepayers be taken on a by-law to provide $35,000 for the purpose.

Halifax, N. S.—The City Electrician has submitted a report to Council showing the probable cost of lighting the city by a municipal plant. The question of installing the same will be considered at an early date.

Ashcroft, B. C.—The Water and Power Co. will erect a power house and install an electric plant.

Ottawa, Ont.—The Ottawa Electric Co. will increase the plant of their No. 2 power house by adding a 60-inch water wheel and a 125-light arc generator.

Winnipeg, Man.—The Western Electrical Company has made a proposition to the city to establish a telephone system.

J. ALCIDE CHAUSSE.

PROPOSED INSTALLATIONS.

Pittsburg, Pa.—The Pennsylvania Tube Works Co. have completed arrangements for the establishment of a $100,000 electric plant in its great works and the operation of the entire plant by electricity.

Lawrence, Kan.—The newly organized Lawrence Railway Co. will build a system of electric roads to handle passengers, freight and mail.

Thibodeaux, La.—The Mayor may be addressed for information concerning electric light plant.

Chestertown, Md.—Atlee H. Tracy, vice-president and treasurer of the Chestertown Electric Light Co., contemplates the erection of an ice factory with a capacity of ten tons every twenty-four hours.

Kalamazoo, Mich.—The Kalamazoo Valley Electric Co. will develop the water power of the Kalamazoo River at Allegan and will distribute electricity to Allegan, Otsego, Plainwell, Kalamazoo and Battle Creek for light and power.

St. Louis, Mo.—The St. Louis, Fenton and Southwestern Railroad Co. will erect an electric power plant; electricity will be generated by water power.

Somerville, Tenn.—The Mayor may be addressed concerning the issuance of $10,000 worth of bonds for the construction of water works and erection of electric light plant.

Little Falls, Minn.—County Clerk may be addressed concerning proposed erection of municipal electric light plant.

NEW YORK ITEMS.

MR. NEFF, president of the Bradford Belting Co., one of the largest belt manufacturing concerns in the world and manufacturers of the celebrated "Monarch" insulating paint, is in town at the headquarters of the concern's New York agent, Elmer P. Morris, 15 Cortlandt street.

MR. T. S. SPEER, the genial secretary of the Partridge Carbon Co., of Sandusky, Ohio, was in town this week, on his way home from the American Street-Railway Association meeting in Boston. He also attended the meeting of the New York Street-Railway Association at Manhattan Beach, accompanied by Harry M. Shaw, the New York agent of the Partridge Carbon Co.

MR. ELMER P. MORRIS, of 15 Cortlandt street, was certainly the hero of the Boston Meeting of the American Street-Railway Association. The ladies who attended the meeting will testify to this. His "bow" ideal of a souvenir was the most taking, and taken, thing at the exhibition Hall.

THE AMERICAN IMPULSE WHEEL COMPANY, of 120 Liberty street, note a gratifying demand for their water wheels. They have lately received a large number of orders from the West, where their wheel is meeting with the greatest success.

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DE VEAU & COMPANY, 27 Rose street, are working day and night to catch up with their orders for their well-known telephones.

C. L. WARRICK & CO., of 39-41 Cortlandt street, report an encouraging outlook for fall trade and are prepared to fill orders for their well-known "Essex" incandescent lamps, enclosed arc lamps, dynamos and motors. They also install complete plants for electric lighting and power.

FRANCIS GRANGER, Eastern sales agent for the Corning Brake Shoe Company, of Corning, N. Y., with offices at 35 Nassau street, was one of the most popular salesmen at the meetings of the American Street-Railway Association and the New York Street-Railway Association at Boston and Manhattan Beach respectively.

NORMAN McCARTY, representing Hugo Reisinger, 11 Broadway, importer of the celebrated "Electra" Nuernberg Carbons, is one of the successful salesmen and popular men among central-station managers and is receiving some fine orders for "Electra" carbons.

Philip P. Nungesser, of the Nungesser Electric Battery Company, Cleveland, Ohio, was in town lately, and took a number of large orders home with him.

A. L. DANIELS, room 27, Telephone Building, representing the H. B. Camp Co., manufacturers of Camp's underground and interior conduits, of Aultman, Ohio, is supplying the Metropolitan Street-Railway Company with thousands of feet of Camp's conduits which are being installed all over the city, notably on Sixth avenue and Broadway.

A. WIRSCHING & SONS, of 61-63 Duane street, state that they are kept continually busy in order to catch up with back orders. They are manufacturing electricians, making a specialty of model and experimental work. They also deal in electrical instruments, telegraph supplies, printing telegraphs and appliances, etc.

NEW INCORPORATIONS.

Lawrence, Kan.—The Lawrence Railway Co. has been incorporated by R. W. Ludington, T. J. Sweeney, S. P. Moore, and others. Capital stock, $250,000.

Meyer, Ill.—Missouri and Illinois Telephone Co. has been incorporated, with a capital stock of $2,500.

New York, N. Y.—Electrical Export Co. has been incorporated; to deal in electrical goods. Capital stock, $20,000.

Jersey City, N. J.—Consolidated Incandescent Light Company has been incorporated by Thomas F. Bedle, Pierre F. Cook and Francis H. McGee. Capital stock, $500,000.

Chicago, Ill.—Jefferson Electric Light Co. has been incorporated by M. A. Ford, Harry Ferguson and William M. Copeland; for electric light and power purposes. Capital stock, $50,000.

Havana, Ill.—Havana Telephone Co. has been incorporated, with a capital stock of $5,000.

Jackson, Miss.—The Jackson Light, Power & Railroad Co. has been incorporated by S. T. Carnes, H. H. Corson and others. Capital stock, $150,000.

Westfield, N. J.—Iron Clad Resistance Co. has been incorporated, with a capital stock of $25,000; to supply electricity.

Albany, N. Y.—The Buffalo, Tonawanda & Niagara Falls Electric Railroad Co., a reorganization of the Tonawanda Street Railroad Co., has been incorporated by Henry B. Smith, H. M. Gillett, T. E. Ellsworth, James A. Roberts and others. Capital stock, $1,250,000.

Portland, Me.—F. L. Merrill Co. has been incorporated by George C. Owen and Fritz H. Jordan; to deal in hardware and electrical supplies. Capital stock, $100,000.

Kalamazoo, Mich.—The Kalamazoo Valley Electric Co. has been organized by W. A. Foote, J. B. Foote, C. H. Frisbee, R. H. C. Hoagland and S. S. Hurlburt. Capital stock, $100,000.

Clarksdale, Miss.—The Clarksdale Water & Light Co. has been incorporated by Walter Clark, E. L. Anderson, W. P. Holland, P. H. Porter and W. D. Cutrer. Capital stock, $35,000.

New York, N. Y.—The Storage Battery Supply Co. has been incorporated by T. D. Bunce, F. E. Foster and W. E. Foster. Capital stock, $12,000.

Charlotte, N. C.—The Southern Electrical Co. has been incorporated by S. B. Alexander, Jr., and others; and has purchased and will succed the electrical department of the Charlotte Machine Co. Capital stock, $10,000.

Winona, Miss.—The Winona Ice, Electric Light & Water Co. has been organized by E. B. Blackston, D. B. Turner, C. S. Harris, William H. Witty, and others; for the erection of an electric light plant. Capital stock, $100,000.

Woodruff, S. C.—The Home Telephone Co. has been incorporated, with E. F. Pearson, president; L. H. Irby, secretary, and S. J. Workman, treasurer.

It is well known that the absorption of ordinary light causes the production of heat. It has now been shown that the Roentgen rays are capable of causing the same effect. X rays passing through a diaphragm of lead were allowed to impinge upon a vacuum tube containing platinum foil. The absorption of the rays by the apparatus caused a perceptible rise of temperature. That this was not due to any stray radiant heat wandering about was proved by putting a source of heat nearer to the tube than the X radiator was, and observing that no effect was produced on the tube with the platinum.—London Invention.

Sioux City, Iowa.—$50,000 is being expended by the Iowa Telephone Co. on the plant in this city.

Rochelle, Ill.—The telephone system of the Lee County Telephone Company has been completed.

Quincy, Ill.—The Thomson-Houston electric-light plant owned by the same company at Quincy, has been purchased by W. B. McKinley, of Chicago, who represents an Eastern syndicate.

Houghton, Mich.—Peninsular Electric Light & Power Company has increased capital from $150,000 to $200,000.

WESTON STANDARD ILLUMINATED DIAL

STATION INSTRUMENTS.

THESE INSTRUMENTS are based upon the same general principle and are just as accurate as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger, and the working parts are inclosed in a neatly designed dust-proof cast-iron case, which effectively shields the instruments from disturbing influences of external magnetic fields.

WESTON ELECTRICAL INSTRUMENT CO.

114-120 William St., Newark, N. J., U. S. A.

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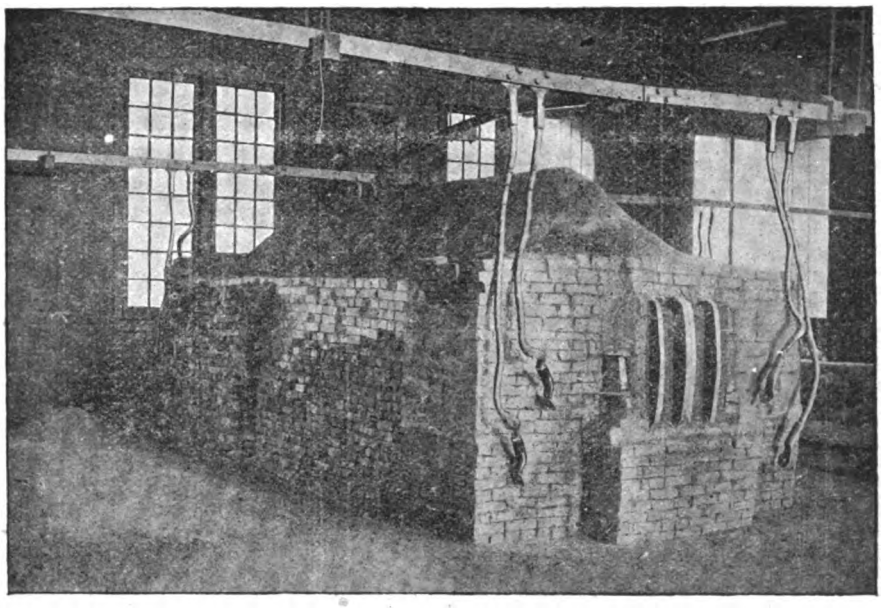
The Electrical Age.

VOL. XXII—No. 13 NEW YORK, SEPTEMBER 24, 1898 WHOLE No. 593

PRODUCTS OF THE ELECTRIC FURNACE.



Carborundum Furnace Ready to Burn.

CARBORUNDUM: ITS ORIGIN, MANUFACTURE AND USE.

O new field of science can develop apart from parallel industries. Associated with the increasing use of electricity, we find a host of new substances dependent upon it for their existence, among which carborundum is certainly the most interesting. To produce this remarkable crystal all that is necessary is an iron pot holding a layer of carbon, serving as one electrode, a carbon rod, acting as the other electrode, and a mass of carbon and clay, through which the current passes. With this simple apparatus and sufficient electrical energy the mixture, raised to a terrific heat for some hours and then allowed to cool, will be found to contain crystals of carborundum.

From a commercial standpoint, this experiment is of tremendous importance. From a scientific point of view, it represents a successful experiment doubly interesting because it points to a new discovery that may be the forerunner of others of inestimable value. In fact, the electric furnace will be the means of solving some of the great mysteries connected with the formation of gems and minerals and, possibly, even the primitive condition of matter itself. Furnaces in which carborundum is made may be called arc and incandescent furnaces. In the first type the electrodes were movable, the arc produced between them being used to play upon the mass from which carborundum would be produced. This system was abandoned, and the incandescent furnace took its place.

Mr. E. G. Acheson discovered carborundum in 1891 and experimented with both kinds of furnaces, finally adopting the second in conjunction with the process involved in its use, on account of its extreme practicability and efficiency. In this furnace a core is used which has either been taken from an old furnace or is built up anew from a mixture of sand, salt, sawdust and coke. Carborundum is the carbide of silicon, but was supposed to be a combination of carbon and aluminum until further experiments proved clearly that silica was indispensable, the quality of the carborundum depending entirely upon it. As larger and larger furnaces were used, the preliminary processes gave rise to a purer and better product than ever before.

In 1895 the furnace room of the Carborundum Company, at Niagara Falls, N. Y., held five actively operating furnaces. Each furnace was nine feet long, one foot nine inches deep, one foot eleven inches wide, and held a core eight feet long. The furnaces in use today are sixteen feet long, five feet wide and five feet deep. The core formerly used was rectangular in cross-section, but has been changed to one that is circular, measuring nine inches in diameter. Difficulty was experienced at first, due to the formation of gases in the incandescent mass and the formation of craters, with a subsequent eruption like that proceeding from a miniature Vesuvius. By mixing sawdust with the sand, coke and salt, the mixture, being filled with interstices, allows the free escape of gases to take place without these symptoms.

In the larger furnaces three hundred pounds of carborundum per day is produced. In the original small-sized furnaces a quarter of a pound per day was all that could be obtained. Two thousand horse power hours are required in a furnace possessing a capacity of three hundred pounds of carborundum a day; consequently each pound of carborundum produced requires a consumption of seven horse power hours. In preparing the constituents of the mixture for use, neither the sand, sawdust nor salt require further treatment, but the coke is put through a grinder and then through two cylindrical screens. In the first the coke dust is removed, while in the second the meshes are sufficiently large to allow those particles required for building up the core to fall through.

The weighing and mixing is done very readily by two men, and the mass is then brought to the furnace. Each

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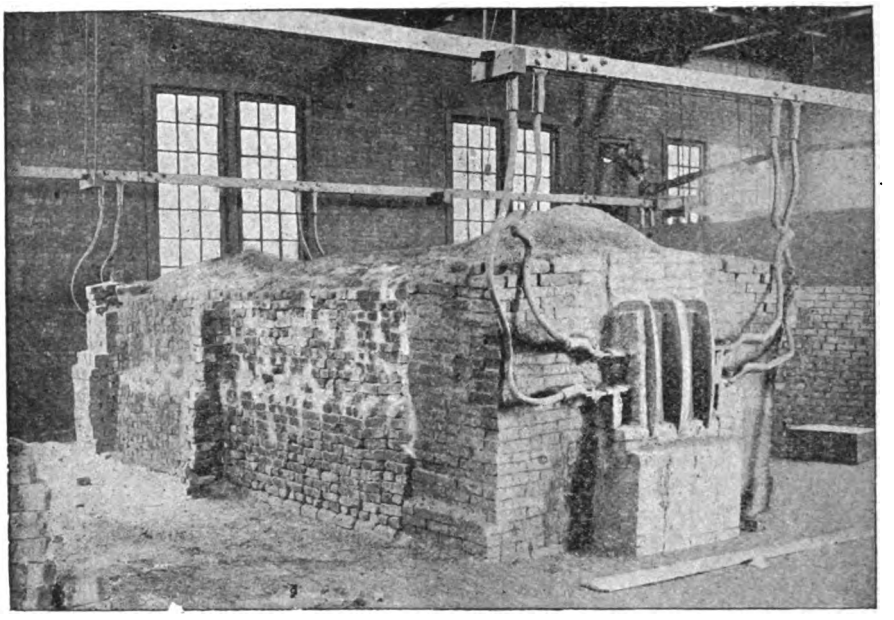
furnace is supplied with two terminals, consisting of sixty carbon rods, three inches in diameter and thirty inches long. An iron frame holds them in place; a plate of the same metal is bolted to the frame, with holes bored opposite each carbon rod. A copper rod three-eighths of an inch in diameter fits tightly into each carbon end. The interior of this box-like arrangement is then filled with graphite, tightly packed to make good contact. Heavy ribbed projections allow for connection with electric cables.

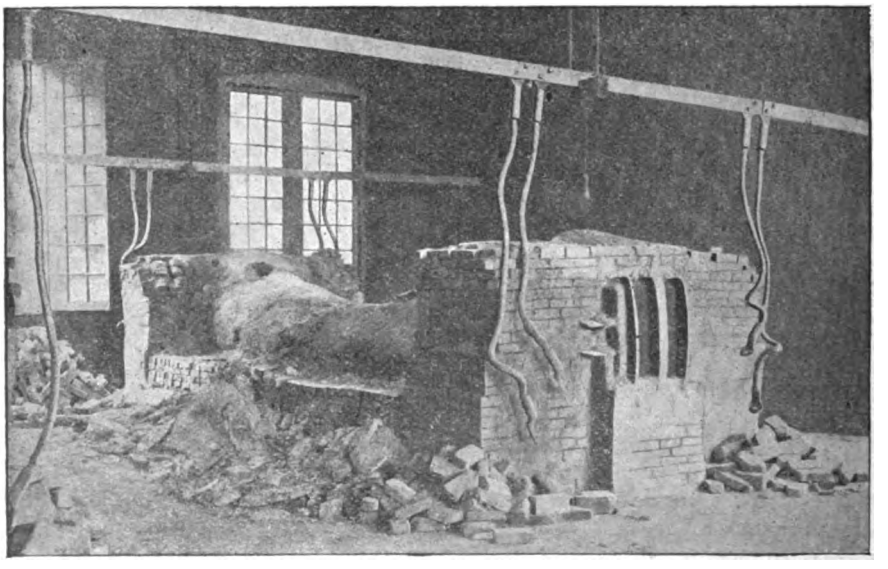


Carborundum Furnace Burning.

The electrical apparatus required for the manufacture of carborundum consists of a transformer, the second largest in the world, having a capacity of eight hundred and thirty K. W., or eleven hundred horse power. It transforms a twenty-two-hundred-volt current, received from the Niagara Falls Power Company, down to one hundred and eighty-five volts. The transformer possesses a regulator, the function of which is to raise the pressure to two hundred and fifty volts or reduce it down to one hundred. To keep the transformer cool and effectively dissipate the forty horse power wasted in it as each oil is circulated through it by means of a small pump driven by a motor. The oil flows from one tank placed eight feet above the floor to the transformer. The upper tank is kept cool by means of two coils of pipe carrying cold water. The pump drives the oil through the entire system, which includes, in all, the regulator, transformer and upper oil tank. The tank resting on the floor merely receives the overflow of oil. The oil being an insulator, may be freely circulated without risk, and, if kept cool, rapidly carries off all excess heat.

From the transformer two copper conductors lead into the furnace room. Each of these conductors is eight square inches in cross-section. In the transformer room is a rather unique switch. A great iron vessel, circular in shape, holding a solution of salt and water, has suspended in it an iron plate. The iron plate connects to one pole of the circuit, and the iron vessel to another. When it is to be closed the iron plate is lowered into the water and touches the bottom. When the circuit is to be opened the plate is lifted completely out of the saline solution. This simple method of opening and closing the circuit saves expense, danger and difficulty.

The core is built up to within four inches from the carbon terminals at either end. The space between each end of the core and the inner extremities of the carbon rods is filled with finely ground coke. Pieces of sheet iron are used to limit the length of the core during its building up. They are removed after the coke filling has been made. These furnaces are sixteen feet long inside,



Carborundum Furnace After Burning.

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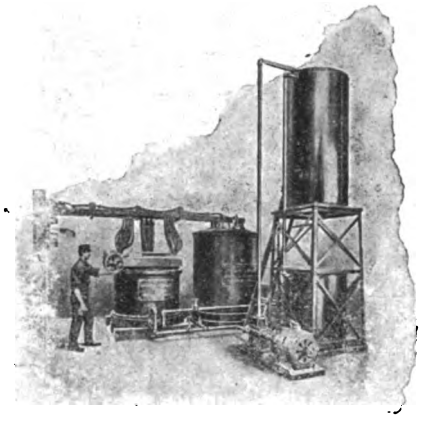
five feet wide and five feet deep. At the bottom of each is a canal of cylindrical shape, ten and one-half inches in radius and the total length of the furnace. This canal receives the core, which weighs eight hundred and fifty pounds, if it has been previously used, or eleven hundred pounds if it is fresh and new.

A practical experience with old and new cores is an immense advantage in the manufacture of carborundum. The old core possesses a much greater conductivity than the new core. With an old core the current rises up to twelve hundred amperes. With a new core, in the begining the current is very small. The resistance of either a new or old core rapidly diminishes, the carbon having a lesser resistance hot than cold. With an old core the energy consumed in one hour will reach one thousand horse power. The current is systematically reduced until the core possesses a fixed resistance; it then flows through uniformly At the end of twenty-four hours the current is discontinned and the furnace allowed to cool. Meter readings taken at regular intervals of a quarter of an hour give, by calculation, the total watt consumption in each furnace.

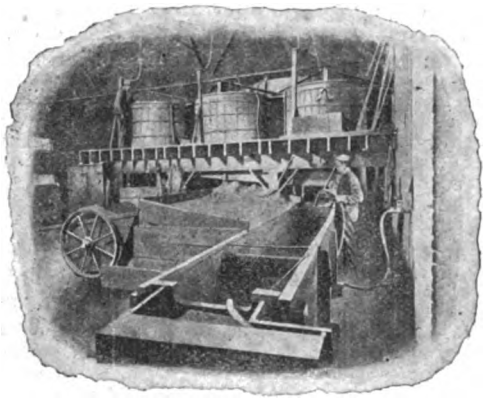
The core of a carborundum furnace possesses an outer layer of almost pure graphite, which was first mistaken for carborundum crystals. An examination of this material leads to the conclusion that graphite is not formed directly from carbon, but combines, during incandescence, with some other compound, which is subsequently decom-



One of the Largest Transformers in the World.

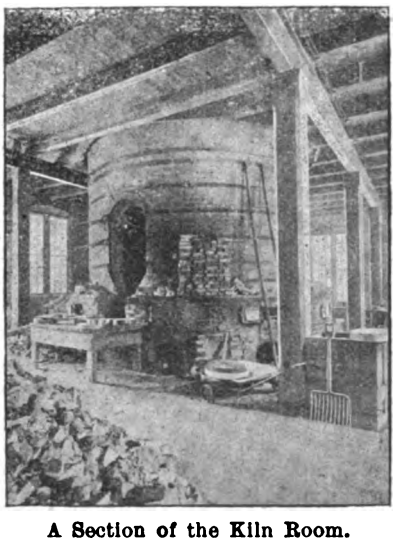
posed, leaving behind crystals of graphite. While the current is passing through the furnace, gases escape in large quantities, a single furnace throwing off thousands of cubic feet of carbon monoxide.

The following description of the manufacture of carborundum in a furnace from the time the current is applied until discontinued may be found in a lecture delivered before the Franklin Institute, December 11, 1896, by Francis A. Fitzgerald, on "the Manufacture and Development of Carborundum at Niagara Falls." "After the circuit has been closed in the transformer-room no apparent change occurs in the furnace for about half an hour. Then a peculiar odor is perceived due to escaping gases, and when a lighted match is held near the furnace walls the gas ignites with a slight explosion. When the current has been on for three or four hours the side walls and top of the furnace are completely enveloped by the lambent blue flame of carbon monoxide gas, formed by the combination of the carbon with the coke with the oxygen of the sand. At the end of four or five hours the top of the furnace begins to subside gradually, fissures form along the surface, from which pour out the yellow vapors of sodium. Occasionally the mixture on the top of the furnace is not sufficiently porous to allow the rapid escape of the gases; the result is that the latter accumulate until the pressure is so great that at some weak in the mixture above a path is forced open and the gases rush out violently. This is termed 'blowing' by the workmen, and the phenomena accompanying it are frequently as follows: a fissure suddenly forms at some point in the top of the furnace, and from this burning gases rush out with a loud, roaring sound. A miniature crater rapidly forms, from which white-hot cinders are thrown to a height of several feet, the issuing gases meanwhile burning with a dazzling yellow flame, dense white vapors soon



Where Carborundum Receives Its Chemical Treatment.

filling the furnace-room. In a bad case of this kind it is necessary to shut off the current from the furnaces and allow the latter to cool down somewhat. Then the mixture surrounding the crater is dug out to a depth of about two feet, exposing the blowhole, which is removed, and the cavity formed filled up with fresh mixture. At the end of about twenty-four hours the furnace is allowed to cool. Then the side walls are taken down and the unchanged mixture raked off the top of the furnace until the outer crust of amorphous carborundum is reached. This crust is cut through with large steel bars and can then be easily removed from the inner crust of amorphous carborundum. The inner crust is next removed with a spade and the crystalline carborundum exposed." Around the original core the carborundum crystals may be found which, in a furnace of this kind, amounts to four thousand pounds. These crystals are exceedingly beautiful. They are in fact but slightly removed from the diamond and might, if found in nature in limited quantities, be just as precious. But nature does not produce carborundum. The temperature at which it is produced is so near the point of its decom-



A Section of the Kiln Room.

position that, unless conditions be artificially controlled, its production is impossible. The cross-section of the core governs the temperature of the mass, therefore, if this is retained at a certain area the crystalline formation of carborundum is assured. The output of each furnace

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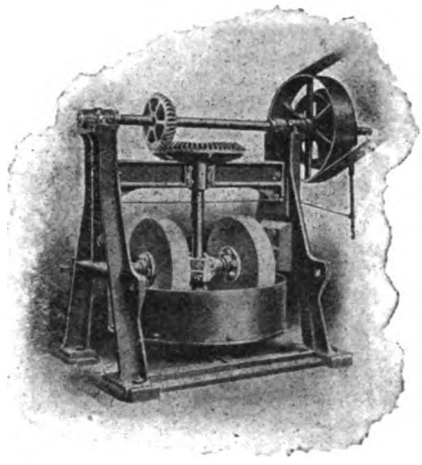
in carborundum crystals is solely dependent upon the core. After the carborundum has been removed from the furnace it is crushed in a grinder, then washed in a bath of dilute sulphuric acid. This takes several days, after which it is dried and the various sized crystals assorted, ranging from number 8 to number 220; that is to say, the number 8 size will pass through a screen having eight meshes to the inch, and intermediate sizes, up to 220, are correspondingly finer. The powdered carborundum consists of the F, FF, and FFF grade. These grades are determined by the length of time it takes for the finer particles, when mixed with water, to settle to the bottom. Naturally the finest grade of flour carborundum, taking the longest time to settle, is the last to be labeled. Carborundum, in comparison with emery, is cheaper in the end, because it will do more work, faster work and better work than this material. The carborundum wheel, being lighter than the emery wheel, is considerably safer at high speed. The Carborundum Company manufacture wheels whose diameters reach from thirty-six inches, or three feet, to one inch, the wheels varying in



The Grinder.

thickness from four inches to a quarter of an inch. The immense variety of wheels manufactured by this concern will reach to such figures as eighty thousand. This does not include special forms, dental wheels, hones, sharpening stones, cloth, paper, etc.

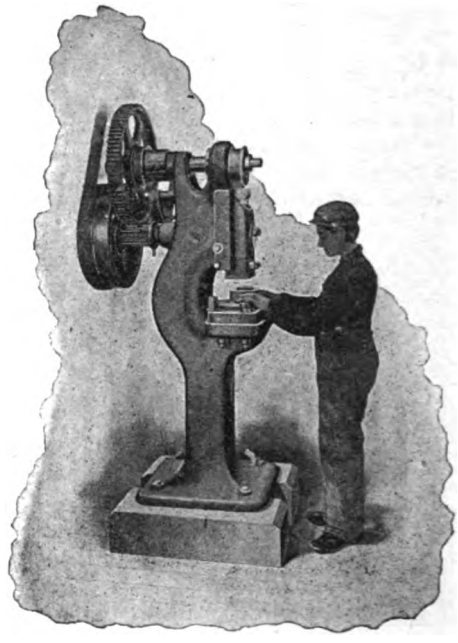
Carborundum is generally placed on the market moulded into shape with kaoline and felspar. A hydraulic press is used for this purpose. The wheel or moulded article is then burned in a kiln for seven days. The intimate mixing of the carborundum with kaoline and felspar, and the subsequent firing, makes a wheel of tremendous strength and durability. The vitrified bond is not the only one employed, shellac being occasionally used. Carborundum has displaced the diamond with watchmakers, and emery with shoe manufacturers. Its lasting properties in this case are six times as great. Plate-glass manufacturers invite its use, and, for smoothing up "biscuit ware," porcelain and pottery firms find it a superior article. For the grinding of car wheels its reception has been most enthusiastic, and in many other cases too numerous to mention, it has found permanent application. The Carborundum Company of Niagara Falls, N. Y., have developed the manufacture of their product on scientific lines. They have reduced operating expenses to a minimum, and consequently offer their goods to consumers at the lowest market price.

The executive officers are, Mr. E. G. Acheson, president; R. B. Mellon, vice-president; H. H. Williams, treasurer; W. H. Arison, secretary, and F. J. Tone, superintendent. The board of directors is composed of Messrs. A. W. Mellon, of Pittsburg, Pa.; R. B. Mellon, of Pittsburg, Pa.; W. C. McCallister, of Monongahela, Pa.; W. H. Arison, of Niagara Falls, and E. G. Acheson, of Niagara Falls, N. Y.

THE PRESENT AND PROSPECTIVE SUPPLY OF CALCIUM CARBIDE.

The rapidly increasing use of acetylene has pushed the demand for calcium carbide so close to the present limit of available supply that the questions of increased productive capacity, the future output, and probable price of this new and important material assume a definite international interest.

It is understood that the use of acetylene, and consequently the consumption of carbide, has increased somewhat more rapidly in America than in Europe, and that, notwithstanding the large output at Niagara Falls, the home demand has rather more than kept pace with the supply. The latter may practically be also said of Europe, at least of Germany, which country, notwithstanding its preeminence in all kinds of chemical manufacture and all that one hears and reads of new plants



Small Press.

projected or under construction, still obtains almost its entire supply of carbide from Switzerland, notably from the great works at Neuhausen.

A year ago about the only manufacturer of carbide in Germany was a company at Bitterfeld, in Prussian Saxony, which smelted the lime and carbon by electrical heat generated by steam power, and found itself, for that reason, unable to compete, and so suspended operations and removed its plant to Neuhausen, where it has reopened with water-power generators and a largely increased capacity.

The whole carbide industry, so far as central Europe is concerned, is now in a transition stage, and the conditions of supply and price are likely to be greatly modified by the increased production of next year. The Compagnie Genevoise, at Vernier, on the Rhone, near Geneva, has greatly enlarged its plant and is making contracts for 1899 at a considerable reduction from present rates.

But the most important accession will come through the operations of the great combination headed by the Schückert Electrical Manufacturing Company, at Nuremberg, which, as is stated on published authority, will increase its capital to 28,000,000 marks ($6,664,000) and expects to have in operation during the course of next year the following carbide factories:

	Horse-power
Electrical Works Lonza, at Gampel (Wallis) .	2,500
Electrical Works Hofsland, at Sarpborg, Norway,	5,000
Bosnian Electrical Company, Iajce, Bosnia, .	8,000
Société Espagnole, Brega (Catalonia) . .	2,500

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The aggregate annual product of these four plants is estimated at 20,000,000 kilograms (20,000 metric tons), capable of generating 6,000,000 cubic meters (211,896,000 cubic feet) of acetylene. Besides these, the Aluminium Industry Company, of Neuhausen-on-Rhine, has this year increased its capital to 16,000,000 francs ($3,088,000) for the purpose of constructing a 7,500-horse power plant at Land-Gastein, in Austria. All these establishments will employ the original process, by which the lime and carbon are smelted together by the heat of an electric current.

The Walther process, briefly described in a former report of this series,† smelts the same materials by the heat of darting acetylene flames intensified by mechanical pressure, and is employed by a company at Leipsic, which has works at Cassel, and now advertises its product in the special organ of the carbide industry. Although this company is said to have exhibited at Berlin carbide samples of very high quality, there seems to prevail among business men some doubt—which may be only the conservative prejudice that discredits all new things—as to whether this process can be made to compete economically with electrical heat generated by water power under favorable conditions. So far as can be ascertained, a favorably located and well-managed water power plant in Germany or Switzerland ought to produce carbide of standard quality at a net cost of 160 marks ($38) per metric ton, and it is doubted whether this minimum figure can be much reduced by any process now in practice. The consumption of acetylene will have to increase rapidly after next winter to keep pace with the great augmentation in the carbide supply that will then occur.

Already the effect of this future increase in production exerts a definite influence upon contract prices, and a large purchase for next year's delivery has recently been made at a reduction of 20 marks ($4 76) per 100 kilogram (220 pounds) from the market price of the same firm for 1898. Carbide is a form of merchandise which varies exceedingly in price according to the quantity involved in the transaction. So far as can be ascertained, manufacturers now receive from railways and other consumers or wholesale dealers who purchase in large quantities from 34 to 35 marks ($8.09 to $8.33) per 100 kilograms, packing charges not included. Consumers of small quantities have to pay to dealers from $10.25 to $11.90 per 100 kilograms, exclusive of packing, the price between these two figures being governed by the quantity purchased.

The standard guaranteed strength is 300 liters of gas per kilogram of carbide, and the present situation may be summarized as follows:

There is now in the European market no apparent surplus of carbide, and the current supply is taken up as fast as it is turned out.

There is even a demand that would justify some importation, provided the foreign-made carbide were of standard quality and could be furnished at prices within the local market rate and under conditions of delivery and payment that prevail here.

This situation can probably not continue beyond the close of the present year. The several large new carbide plants that will be started up next winter and spring will so increase the output as to probably reduce the market price to a fair profit above net cost of production, and, unless the use of acetylene increases phenomenally, leave a surplus that will be available for export.

Calcium carbide is, however, a somewhat critical kind of merchandise for international traffic. The requirements of railways and steamship companies in respect to packing, etc., are so costly and difficult of fulfilment that in one recent case a large order of carbide for China had to be canceled because it was impossible to comply with the specifications for its transportation.

† See Consular Reports No. 206 (Nov., 1897), p. 337.

FLASHES.

Livingston, Mont.—The Livingston electric light plant, damaged by fire at a loss of $32,000; insured for 24,000.

Fitzgerald, Ga.—Moore & McRary have been awarded contract for construction of electric-light plant.

Slater, Mo.—Electric-light plant dynamo burned out, and city left in darkness.

CONDUCTORS.

THE RELAVIVE COSTS OF COPPER, ALUMINIUM, AND IRON WHEN USED AS ELECTRICAL CONDUCTORS.*

By John B. C. Kershaw, F. I. C.

In an article published by the writer in August, 1897, it was shown that at the prices of aluminum and of copper current at that date, the former metal was one and a half times as costly as the latter when used for electrical conduction purposes; the cost ratio being calculated for wires of equal conductivity.

Early in the present year Mr. A. E. Hunt, of the Pittsburg Reduction Company, published a similar article,† and, taking as his basis of calculation figures slightly different from those used by the writer in his earlier article, he proved that so far from aluminum being the more costly metal for electrical transmission, it was slightly the least costly of the two.

Since the subject is an important one, the writer has thought it advisable to recalculate the relatlve costs of aluminum and copper conductors of equal electrical capacity, using in the one case Mr. Hunt's data, and in the other case his own; in order to include in the comparison a third metal which has more than once been proposed as a medium for the conduction of large electrical currents, such as those used in electro-chemical and electro-metallurgical works, he has extended the calculations to the corresponding values for iron.

In the following expressions

S = sp. gr. of copper,
P = cost price per pound of copper,
C = conductivity of copper,

and s p c represent the corresponding values for the metals, aluminum and iron.

It is evident then that the expression

$$\frac{S \times P}{s \times p}$$

will represent the relative costs of equal lengths of wire of equal sectional area, and that the expression

$$\frac{S \times P \times c}{s \times p \times C}$$

will represent the relative costs of equal lengths of wire of equal electrical resistance.

The values used by Mr. Hunt in his article upon the use of aluminum as an electrical conductor are the following:

Copper.		Aluminum.	
S =	8·93	s =	2·68
P =	14 cents per lb.	p =	29 cents per lb.
C =	100	c =	63

Substituting these in the expression given above, we

* London Electrical Review.

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have $\frac{8.93 \times 14 \times 63}{2.68 \times 29 \times 100}$ which equals $\frac{7,876}{7,772}$ or, $\frac{101}{100}$, as the relative costs of copper and aluminum wire of equal lengths and equal electrical resistance. This ratio is in close agreement with that found by Mr. Hunt by a somewhat more indirect method of calculation.

Taking next, values for copper and aluminum less arbitrary than those selected by Mr. Hunt, and repeating the calculation, we have—

Copper.	Aluminum.
$S = 8.93$	$s = 2.68$
$P = 5.94$d.† per lb.	$p = 15.85$d.† per lb.
$C = 100$	$c = 59$ (99 % aluminum.)

and $$\frac{8.93 \times 5.94 \times 59}{2.68 \times 15.85 \times 100} = \frac{100}{135}$$

This result confirms the early calculation of the writer, and shows that for conducting purposes 99 per cent. aluminum at the present market prices of the two metals is 1⅓ times as costly as copper. The cost of converting the ingot metal into wire of equal electrical resistance would not materially affect the ratio, since, although the copper would be of less sectional area and consequently would have to be passed through a greater number of draw-plates, greater care would have to be exercised in the case of the aluminum, and the costs of drawing would probably be about the same. Aluminum of 99 per cent. purity has been taken for comparison. because 100 per cent. aluminum is not yet a commercial product, and the writer doubts whether the Pittsburg Reduction Company, or any other aluminum producing company, will ever be able to produce 100 per cent. aluminum in wire or rod form profitably, at the price taken in Mr. Hunt's calculation, namely, 29 cents per lb.

The values for iron and the calculation of the relative costs of copper and iron when used for conducting purposes are given below :

Copper.	Iron.
$S = 8.93$	$s = 8.10$
$P = £55$ 10s. per ton.	$p = £3$ 12s.
$C = 100$	$c = 16.4$

and $$\frac{8.93 \times 1,110 \times 16.4}{8.10 \times 72 \times 100} = \frac{162,661}{58,322} = \frac{2.78}{100}$$

This result shows that if iron can be produced in bar form with a conductivity of 16.4 Matthiessen standard, at a price of £3 12s. per ton, it is by far the cheapest metal for electrical transmission purposes ; and, though its weight as compared with copper or aluminum prevents its use for overhead lines, there would seem to be no reason why it should not be used for underground conduits, or for electrical current transmission in works and factories where the lightness of the conductor is of entirely secondary importance, and where the current is of low potential.* The liability of iron to rust could be overcome by artificially forming the protective oxide, $Fe_3 O_4$, as a skin upon its surface in the manufacturing operations, or by applying a coating of tar at a later stage.

Gathering the results of these calculations together, and expressing them as cost ratios to iron, taking the latter as 100, we have

Relaitve Costs of Conductors of Equal Length and Equal Electrical Resistance.

Metal.	Purity and Price.	Relative Costs.
Aluminum	99 per cent. at present market prices	375
Copper	Electrolytic " " "	278
Aluminum	100 per cent. at A. E. Hunt's value	275
Iron	At present market price, plus 38 per cent. for rolling costs	100

* The *Aluminum World*, February, 1898, also ELECTRICAL REVIEW, 42,

† These prices are taken from current price lists, and represent the true relative values of electrolytic copper, and aluminum at the pr nt date.

WATER POWER INSTALLATIONS.

LACHINE RAPIDS PLANT AND THE COST OF PRODUCING POWER FOR GENERATING ELECTRICITY THEREFROM.*

By W. McLea Walbank.

In order to allow of a fair comparison with other plants of the cost of producing power for generating electricity from the Lachine Rapids plant, the writer considers it desirable to give you a brief outline of the hydraulic as well as the electrical equipment of our works.

The world-renowned Lachine Rapids, as you are all doubless aware, is situated on the St. Lawrence River, a short distance from the city of Montreal.

The idea of converting the wasted energies of these turbulent waters and harnessing them for the use and convenience of man was not new. As far back as 1866 a company was formed, whose object was to erect dams and construct large hydraulic works, about a mile lower down the river than the site of the present power house; their object being to induce factories to establish their works at the rapids, for at that date the possibilities of electric transmission had not been demonstrated. The scheme, however, never materialized, and since that date various projects have from time to time been talked of, but never matured.

In the fall of 1895 the Lachine Rapids Hydraulic & Land Company, Ltd., commenced its operations. The directors commenced work only after having fully satisfied themselves upon the difficulties to be encountered and overcome, and carefully studying the question of back water, frazil and anchor ice, and went in with a determination to succeed.

The company was honestly formed, without "ground floors" or "sub-cellars," with a bona fide capital, on which every share represents one hundred dollars ($100) cash. This, the writer considers, has direct bearing on the cost of producing electricity, because a company handicapped by what is called watered stock, or exorbitant promoter salaries, has to pay interest on money it never had the use of.

Having therefore formed a company on a solid and firm financial basis, the property fronting on the Lachine Rapids, and controlling the water power privileges, was secured, and operations for the development of the water power commenced.

Hydraulic Development.

The hydraulic plant consists of a main dam and power house, one thousand feet long, and a wing dam and guard pier, five thousand feet long, forming a head race or basin with an average depth of twelve feet in low water.

To secure this it was necessary to divert the waters of the St. Lawrence and lay bare the bed of the river for a distance of over a mile and remove over 400,000 cubic yards of rock.

The main dam, which is constructed of a series of isolated cut stone piers, with head gates and stop logs, furnishing in all thirty-six (36) flumes and three (3) waste weirs, at the same time forming foundations for the power house and turbine sheds.

* Read before the National Electric Light Association.

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The Electrical Age.

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A NEW INSULATION FOR CONDUCTORS.

The present method of insulating wires is that involving the use of rubber, gutta percha, cotton and silk. The covering of large wires represents but a small percentage of its diameter. The covering of small wires increases rapidly with respect to the diameter, so that the finer sizes possess a covering of silk, cotton, etc., all out of proportion to their size. Three difficulties present themselves in connection with the covering used at present for electrical conductors. First, the insulation occupies a considerable portion of a space allotted to the winding. Second, the filling up of this space requires a length of wire dependent upon the thickness of insulation possessed by the wire. Third, cotton insulation, particularly, is easily charred by an undue rise of temperature in the winding.

Conductors used for interior wiring or outside lines are, of course, protected by either rubber, gutta percha, or a compound of both. The question of space does not arise, but the ease with which the covering can be attached has given rise on frequent occasions to dead grounds and short circuits. The flexibility of the insulating covering is not always up to the standard, in consequence of which sharp bends in the wire mean a fracturing of the insulation and, possibly, an exposure of the copper core. Generally speaking, wires used for outdoor and indoor use are otherwise very well protected from injury. The outdoor wire is supported by insulators and is installed in such a way that, even though its insulation was stripped from it, immediate danger of grounding would be entirely absent. Wires used for interior work, incased in conduits, are similarly protected; a naked wire in such being very nearly as well protected as one covered with heavy insulation.

But for armature and field winding the case is different. Frequently potential differences of ten, twenty-five, fifty, and more than one hundred volts are only separated from each other by the slightest of insulation. The greatest care must be exercised by armature winders in obviating the risks of grounds and short circuits. Cotton covering is readily affected. It deteriorates rapidly under the influence of certain liquids and soldering fluids, and is so readily abraded that considerable difficulty has been experienced in the past and present, due to this fact alone. The proper insulation for a wire is undoubtedly one which adheres tightly to the conductor, possesses a degree of flexibility that will respond to the actions of an external force without breaking, and possesses non-conducting properties great enough to allow of the thinnest applicatinn to insure absolute insulation.

A dressing for wires of this description would certainly insure freedom from many of the faults that cotton and silk possess. It would be more in the nature of a coating than a woven texture, and would save at least five per cent. in the weight of copper used and ten per cent. in the winding space. Manufacturers desiring to build compact machines would, by the use of mild steel frames and a thoroughly reliable insulation, be able to produce motors and dynamos lighter and better than ever before. There is a chance here for some enterprising inventor to discover this new coating for wire.

At present, in order to make certain of the insulation of cotton-covered wires, it is necessary to make free use of shellac, but when a wire is once shellacked, the previous flexibility of the covering completely disappears, and the additional insulation due to the shellac is secured at too great a sacrifice. Hence the necessity for securing both flexibility and insulation in the new covering for wires.

FIRE CAUSED BY A SIMPLE ACCIDENT.

A contemporary of ours, the "Street Railway Review," states that on May 26th, 1898, an employé of the Southside Elevated, Chicago, caused a fire by dropping an iron tool, thereby making connection between a gaspipe and the third rail. The short circuit burnt through the pipe, ignited the gas and caused a fire. Traffic was interrupted for several hours. The wiring in quite a few cars was destroyed and the cars were nearly burnt, and in some few other details injury was wrought to the establishment which figured up to quite a considerable loss. A similar case occurred in New York in which a street laborer, digging near the Edison mains, dropped a crowbar. The short circuit, in this case, was very severe, fuses blowing throughout the station, and the greatest excitement prevailed for nearly an hour. Frantic efforts were made to burn out the short circuit. The laborer was only made aware of this when he attempted to lift the crowbar. The temperature of it gave rise to suspicions on his part that the strength of certain liquid refreshments he had partaken of was greater than he anticipated. The crowbar, having been carelessly thrown down and not used for nearly an hour afterward, did not actually cause a fire but interfered with the operation of the station, and it was not until it was removed that the station was able to supply current to the neighborhood. Simple causes like these have often interfered with the operation of large plants and sometimes caused, in addition to financial losses, a loss of life.

An interesting experiment has just been started on the Philadelphia, Wilmington and Baltimore Railroad in order to find out which is the best wood for telegraph poles. Some forty-two have been set up in order to test the life of the various woods employed. There are six chestnut poles, creosoted; six pine poles, creosoted; six chestnut poles, woodiline; six set in broken rock, six set in clay, six in the ordinary manner, and six to have a hole bored near the ground so that they can be saturated with oil.—Exchange.

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The total development will, when completed, consist of seventy-two (72) vertical turbine wheels and twelve (12) generators. The wheels connected in series of six, by gearing, to a horizontal shaft, at the end of which a generator is directly connected. The completed power house will contain twelve (12) such sets. The whole as shown on the accompanying blue prints.

Of the total installation forty-eight (48) wheels are already in place, and the power house, head race, tail race and dams are completed.

Electrical Equipment.

Each dynamo house will contain four (4) three-phase General Electric alternators, wound for 4,400 volts at full load, and two (2) direct-current exciters at 120 volts. There will be in the total installation three such dynamo houses, containing in all twelve (12) dynamos and six exciters, each exciter being capable of exciting four (4) machines. Each dynamo house will have its own switchboard, of blue Vermont marble, of the very latest design, so arranged that each circuit may be operated from the switchboard of either power house. The floors are of slate and the building of solid brick. The current is generated at 4,400 volts, avoiding the use of step-up transformers, is transmitted on iron poles over bare copper wire to the city of Montreal, a distance of about five miles, to the sub-stations, where the pressure will be lowered to 2,300 volts, and by means af sub-station switchboards subdivided into the desired units and distributed partly through underground conduits, and partly by overhead construction, throughout the city of Montreal and its suburbs, where we find a population of over 300,000 people offering a market for light and power.

Of the total equipment one-third is already installed.

Total Power.

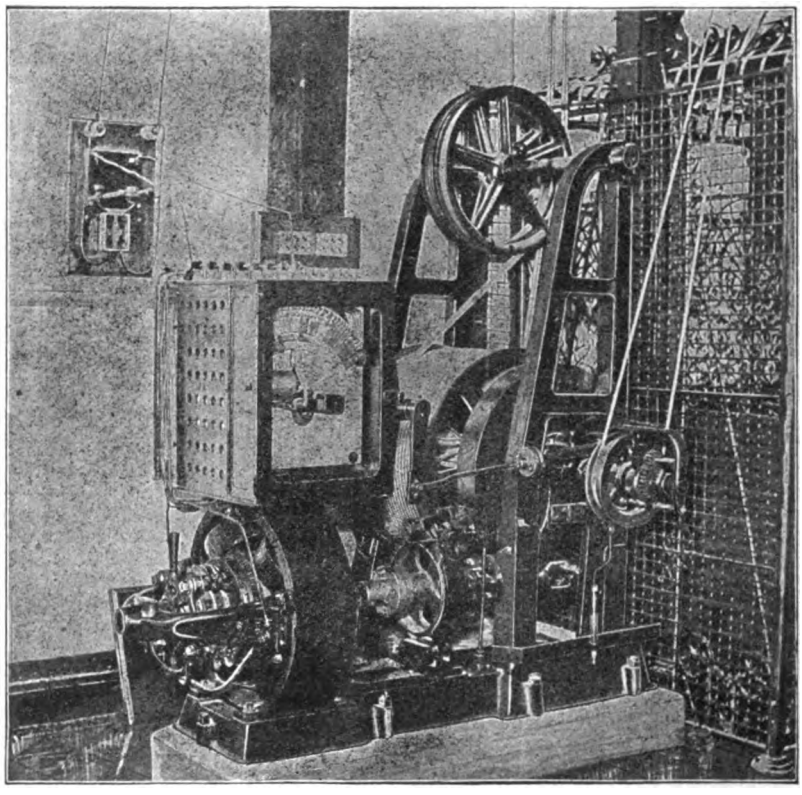
The wheels were tested at the Holyoke testing flume, on April 16th and 17th, 1897, and developed at full gate as follows:

Witu a speed of 76 1-4 revolutions, discharging 235.33 cubic feet of water per second and developing 300.84 horse power, showing an efficiency of 81.32 per cent., which would make the total possible output of our power house about 16,000 kilowatts.

Cost.

Perhaps the greatest obstacle to a fair comparison of electric current produced by water power, as against the same current produced by steam, is the first cost. In the former case, especially if a large water power is to be developed, the expense of the whole installation, such as dams, head and tail races, etc., has usually been made at the commencement, while perhaps only a fraction of the power thus obtainable is at once used, therefore throwing a very much larger capital cost per unit than with a steam plant, which need only install the power necessary for immediate demand and continue increasing or adding thereto, as the demand therefor offers.

(To be continued.)



Commercial Electric Co.'s Elevator Equipment.

LIGHT AND POWER.

ELECTRIC LIGHT AND POWER MACHINERY.

Correctness of design in the construction of light and power machinery usually exercises a great influence upon its future success. Questions of economy have given rise to a new school of design, and in consequence of this the manufacturer desiring to introduce his apparatus with success must feel assured that it will stand the light of scientific criticism without injury. The lighting and power machinery of the Commercial Electric Company, of Indianapolis, Indiana, betrays a care in construction and design that is sufficient in itself to make them worthy of a good introduction. The direct-connected generators are substantially built. The fields are made of mild steel, in consequence of which a given magneto-motive force produces a field of force twice as strong as that given by cast iron of equal cross-section, with the same ampere turns. Pole shoes of cast steel are employed, so as to provide the proper magnetic spray or sparkless commutation. In this respect two birds are killed with one stone—spark-

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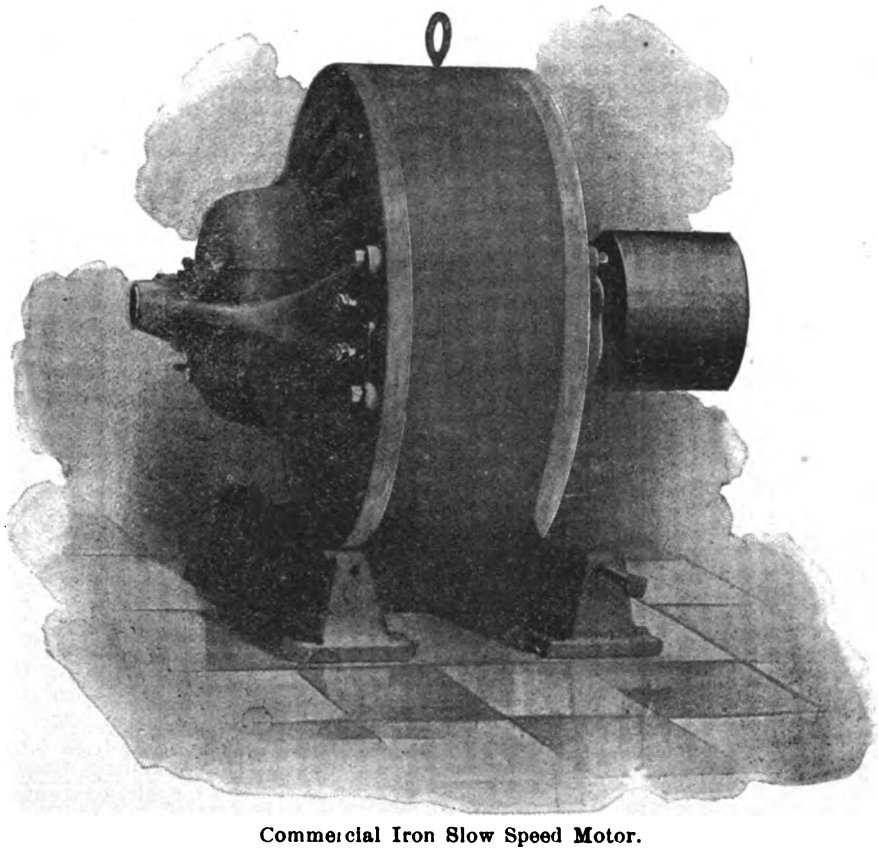
less running, in consequence of which the commutator will remain unaffected for years. The field coils run cool, are wound on spools with brass flanges and are well protected, externally, by a heavy, cord winding. The speed of the armature is regulated according to specifications, although it is the practice of this company to supply two speeds for a given size of machine. The armature adopted by the Commercial Electric Company is of the gramme ring type. The laminated core, it at a healthy temperature at all loads. The commutator, built up of copper segments of uniform temper and insulated from each other with the best India mica, combines strength with usefulness, solidity with long life. The use of carbon brushes on all direct-connected machines relieves them from all but occasional inspection. The regulation is so perfect within the prescribed limits of load, due to a perfect adjustment of parts, that neither brushes nor rheostat under any circumstances

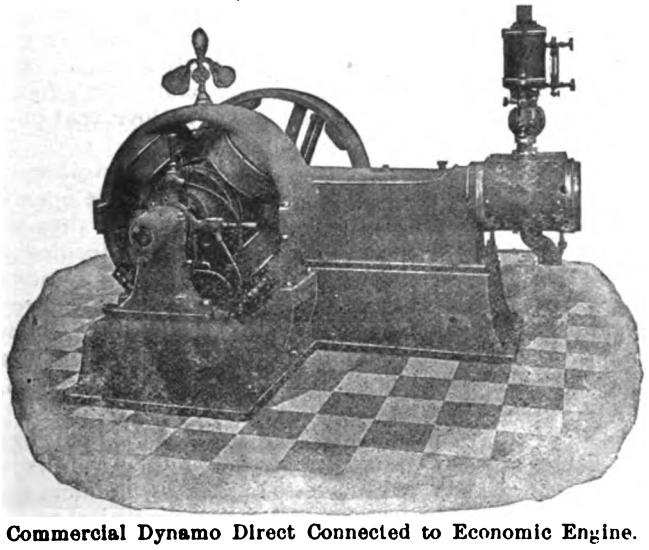


Commercial Iron Slow Speed Motor.

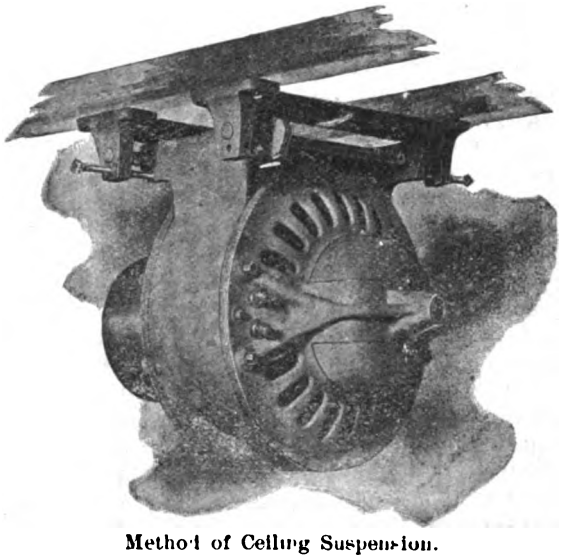
built of the best charcoal iron, is supported by a spider of brass.

The advantages of a gramme armature are obvious. Coils of greatest difference of potential are ninety degrees apart, whereas in the drum armature such coils need ever be touched. In conseqnence of this, motors fed from these generators, whether loaded or not, do not affect its electromotive force or cause a perceptible flicker in the lights.

For direct connection with gas engines, small Commer-



Commercial Dynamo Direct Connected to Economic Engine.



Method of Ceiling Suspension.

overlap each other; this dangerous proximity being the frequent cause of burn-outs. Each coil is separate from its neighbor and can be replaced with such celerity that repairs of this kind would never cause the least embarrassment. Ventilation is not artificially forced in this armature, its immense radiating surface keeping

cial Electric generators have proven their remarkable superiority. Small residential plants of this description require but a minimum amount of attention and, on account of the high efficiency of the generator, give the best possible returns for the cubic feet of gas consumed. One of the great advantages connected wit

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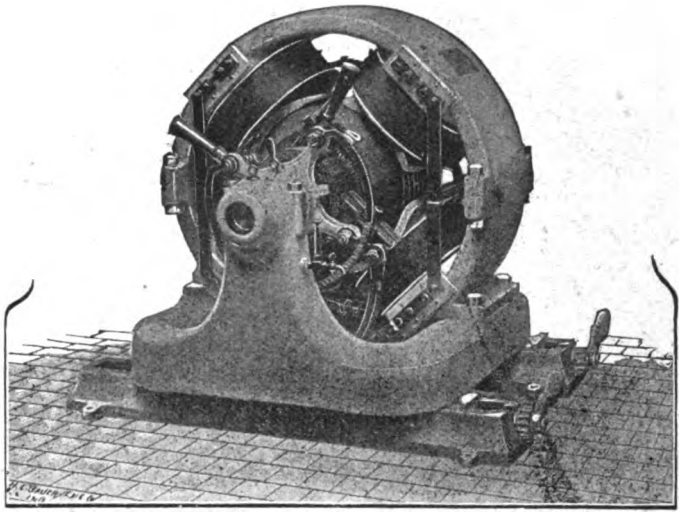
the use of these generators and motors is to be found in their interchangeability of parts; those requiring duplication may be instantly refitted in the time it takes to drop a line to their factory, at Indianapolis, Indiana. The slow-speed motors of the Commercial Electric Company are ideal machines in respect to weight, compactness, efficiency and operation. Ventilation is readily obtained, while at the same time protection is gained by the use of an iron casing. The field frames proper are made of cast steel, the permeability of which, according to Steinmetz, is about that of wrought iron. The field coils, wound on forms, have mica insulation. They are readily removed, and cannot be injured except by absolute carelessness or deliberate intention. The temperature rise is normal, the radiation being perfect. The brushes, of the radial carbon type, are of ample cross-section, can be subjected to a variable tension, and may be easily removed.



Commercial Generator for Direct Connection.

The Commercial Electric Company's motor for ceiling suspension or ordinary floor work is provided with self-oiling bearings, and is built with a field frame of mild steel. Its design, in detail, has been given the same careful attention as the other machines of this company. The motor once installed, either on the ceiling or floor, cannot lose its alignment, as it is rigidly held. On account of its excellent design, it does not heat under any circumstances and will not spark. Being perfectly automatic, after installation they require little or no attention. Each part is interchangeable, and all the comfort and convenience found in the ownership of a modern machine will be experienced by purchasers procuring these types. The Commercial Electric Company's slow-speed electric motors exclude the possibility of injury by dust or climatic changes.

Prepared to meet all exigencies, the generators and motors of the above company represent a form of investment constantly paying dividends to the purchaser. The enclosed motors have a particularly desirable method of support, by which their suspension from the ceiling or installation on the floor will give entire freedom for operating the belt-tightening device without necessitating the loosening of the suspension bolts or other apparatus for holding the machine up. They are very conveniently applied to freight elevators on this account.

LIGHTING OF STORES AND WINDOWS BY ELECTRICITY.

ELECTRIC ILLUMINATION OF LARGE STORES.

In all stores in which the goods require the most perfect display at all times during the business day, such as department and dry goods stores generally, as well as wholesale warehouses where goods are bought from samples, the question of artificial illumination presents a difficulty not, heretofore, easily solved. In no place is it more important to have a perfect light than in stores where clothes, cloths, silks, colored textiles of all kinds, fine glassware, delicate porcelains and chinaware are sold, and in none can a poor light work more harm to the owner by illy showing his goods. Many cases can be recalled in the experience of every store proprietor, in which perfect matches of color by the artificial light on which he has had to depend have turned out unhappy marriages as soon as they were exposed to the pure white light of the sun, to the dissatisfaction of the customer and frequently the loss of his custom. What salesman has not been compelled to carry heavy rolls of cloth or bolts of silk to the store doorway to show that colors and shades are vastly different in the light of day than in the interior of the store gaslit or lighted by open arc electric lamps?

The perfect illumination of dry goods and department stores, and, indeed, all stores of a kindred character, has hitherto been an unsolved problem. Gas burning from an ordinary burner is far too garish and yellow. Used in an incandescent mantle, the light is too greenish and sallow. In both cases, colors are falsified in a manner which the ordinary observer would consider impossible, and which to the practiced eye is almost inconceivable. The primary colors become complementary, and the complementary colors become almost anything. An additional drawback is to be found in the deleterious effect on the eyes of the employes, which tend to lose that power of color selection which is a prime necessity.

To secure a greater volume of light from a single source and to do away with the upright gas flame, the open arc lamp was adopted, first with a clear globe and then with a globe of opalescent glass. This, while a decided advance on gas as a store illuminant, had many disadvantages. When first introduced, separate circuits had to be provided, and not until the introduction of what is known as the incandescent circuit arc lamp, a very few years ago, were arc lamps really within the practical reach of the dry goods store proprietor.

The intensity of the light from an open arc lamp lights up part of the store too brilliantly, while it throws the other part into deep obscurity. Even with the most careful distribution to avoid shadows, the cross lights from the open arcs caused inconvenience. Furthermore, with open arcs, there is always a certain amount of sparking at the arc, by which heated particles of carbon are given off, frequently passing over the top of the globe and falling in the vicinity of the light. As the heat from them is not immediately extinguished, their very presence is a danger. Indeed, in the last report of the Electrical Bureau

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of the National Board of Fire Underwriters occurs this item:

"Sparks from carbons of arc lamps not provided with spark arrester set fire to dry goods stock; loss, $300."

What sparks do not fall outside should tumble through the bottom of the globe into a dust pan, but usually they collect on the interior surface of the globe, to be brushed into the surrounding air and fall upon the goods, or be blown into the eyes of the salesmen or customers when the attendants change the carbons.

Open arcs, burning evenings only, practically consume three carbons every two days. Those used in dark stores and burning all day consume many more. Three carbons for each two days for 300 lighting days is 450 carbons per annum and 300 visits of the lamp trimmer. If the store proprietor pays for his carbons, they cost him each year $13.50; and even if he do not, still he cannot dispense with the lamp trimmer, whose visits are timed for all hours of the day, and to whose inconvenient presence the loss of many a sale can be set down.

Within a very recent period a new type of electric light has been introduced. It has successfully been put on the market by the General Electric Company and owes its development and present perfection to the genius of Prof. Elihu Thomson. It is an arc lamp, with the two carbons burning in an air-tight globe filled with the inert gas which the combustion of the carbons creates. By enclosing the arc in this globe the life of the carbon is tremendously lengthened, and instead of burning only ten hours, they burn from 90 hours, in the arc lamp used with alternating currents, to 150 hours, in that used with the direct current. Apart from the economy in carbons which the use of this lamp brings about, the visits of the trimmer, instead of occurring daily, occur only every ten or fifteen days, or longer, depending, of course, upon the time of year and the period of daily illumination. Roughly, it may be said that with 150-hour lamps and ten hours' illumination per day, trimming is necessary only about twenty to twenty-five times a year, instead of 300 times, and twenty carbons suffice instead of 450—60 cents instead of $13.50. In stores using many lamps, such an economy would have a deep significance.

The frequency of trimming of the open arc lamp largely increased the chance of breakage of the large globes. With the trimming visits reduced to 20 or 25 per annum, the chance of breakage is greatly diminished, and in the G. E. lamps, by the use of a special lowering device, almost wholly eliminated.

The point, however, of greatest importance to the dry goods store is the quality of the light. From the enclosed arc lamp the light emitted is a pure white light, and its diffusion through the walls of the globe is as perfect as possible with any artificial light. The result is almost equal to the light of day, a light which cannot falsify colors, a light under which goods of any color may be shown, with the assurance that if taken to the store door no difference in shade can possibly be seen. It is different from any other light artificially produced, and it is the only light upon which reliance can be placed to give dry goods stores a perfect illumination.

In open rooms each lamp can be depended upon to satisfactorily illuminate 600 sq. ft. of space, but where a department has, suspended from its ceilings, draperies, portieres, rugs, carpets or other samples for display, which necessarily obstruct the light, the floor space illuminated would not be so great, and the lamps would have to be installed more freely.

The enclosed arc lamp is manufactured in two styles, known as the double globe and single globe. In both the mechanism is similar in every respect, and the carbons burn in similar small globes. In the single lamp, however, the place of the large outer globe is taken by a special widely flared glass reflector, with a highly polished under surface. The double-globe lamp is used where an absolutely even diffusion of the light is required; the single-globe lamp where greater intensity and some concentration beneath the lamp is necessary. The enclosed arc lamps are constructed for use on alternating-current circuits, as well as on direct-current circuits, the duration of the life of the carbons being somewhat shorter in the alternating than in the direct-current lamp. For interior lighting both single and double-globe lamps are made up with different styles of ornamental casings in different finishes. For outdoor use the double-globe lamp alone is used in a black japanned casing.

THE WHEELER SYSTEM OF REFLECTORS.

Where light is required of an intensity that must be varied to suit conditions, a system of reflectors must be employed which will distribute the light successfully. The absorption of light energy is what must be avoided during its distribution, hence the efficiency of a system of reflectors is as important as the effects produced by its employment. The Wheeler system of reflectors possesses scientific features which have made their use a practical success on account of the proper relations having been observed between the source of light, the locality to be illuminated and the reflector distributing the light. With this system of reflectors light produced by electricity, gas or oil, is most efficiently utilized.

The silver-plated corrugated reflector of the Wheeler Reflector Company is used for lighting any circular area by arc lights; the light reflected by this appliance is white and powerful. Its diameter is thirty-two inches.

By inverted arc lighting, representing an innovation in the illumination of interiors, all the effects of daylight are successfully imitated. With the light thrown up against the ceiling and reflected from white walls a diffusion of radiant energy is obtained which is equivalent to artificial daylight. These reflectors are green outside and white enamel inside. The billiard-table shade obviates the glare proceeding from a naked lamp and sends down a pleasant, mellow light agreeable to the eyes and in every way conducive to the comfort of the player. They have been universally adopted in public pool-rooms and private billiard-rooms.

The street car fixtures of this company include a great many interesting novelties. Their silver-plated mirror reflector, used in conjunction with a three-light fixture of polished brass, has met with great success. The silver-plated mirror reflector can be used with a fixture holding more than three lights, if required. The illumination produced by this device enables passengers of street cars to read and see with perfect ease.

Foot lights, metal half shades and pulpit hoods represent a class of devices that find their place in the theatre and lecture hall. The foot-light reflectors are green outside and bright tin inside. The metal half shades are green outside and white inside, and the pulpit hood, which will fit a three and a quarter inch shade holder, is bronze outside and glossy white within.

The silver-plated reflector referred to above finds a ready application in commercial establishments, such as stores, exhibition halls, etc. The rays of light are reflected by it over a great area of surface. In construction it is convex and fulfils its functions admirably in projecting the light exactly where required. When it is necessary to throw a strong, clear light upon a limited area, the silver-plated mirror reflector, shown in illustration, with silver-plated mirror plate glass within, is exceedingly effective for show-window lighting and over lathes, work benches and desk lighting. The percentage of light thrown down is very great and is effectively delivered. The incandescent reflector, of about the same shape and size, is merely enamelled white inside and green outside. Its use for architectural and desk work is obvious. The incandescent reflector is made in a variety of sizes. It is provided with rubber or porcelain rings and dispenses in one type with the shade holder. The field of work cov-

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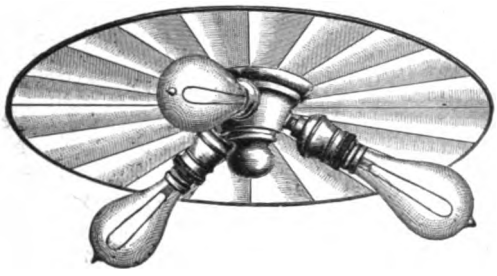
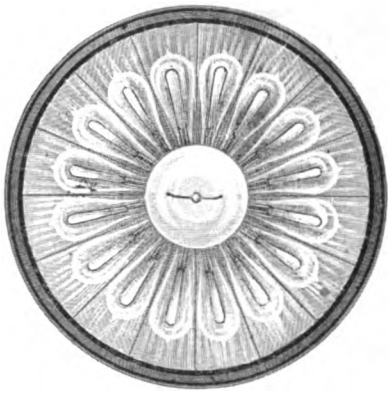
ered by the Wheeler Reflector Company, of Boston, Mass., is large enough to include all systems of interior and outdoor illumination and the use of all known illuminants.



Silver Plated Mirror Reflector.



Under View of Wheeler Window Reflector.

Wheeler Reflector for Incandescent Lamps.

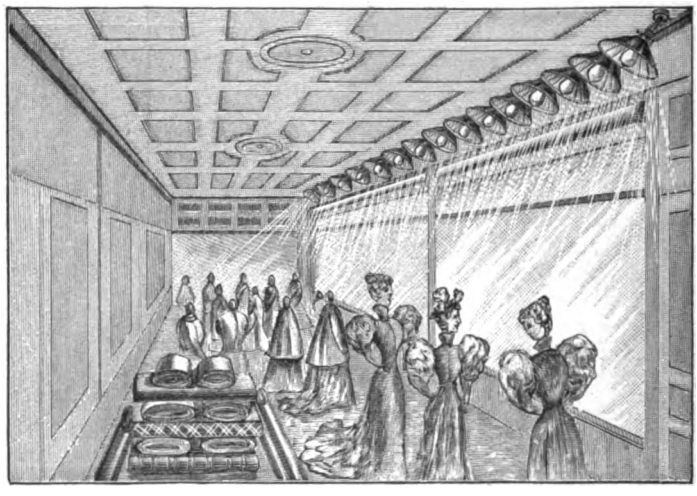
ELECTRIC HEADLIGHTS FOR SURFACE CARS.

Their headlights for electric cars are a familiar sight in all metropolitan cities. The reflectors of these headlights are parabolic. Those used for dashboard or vestibule are provided with a malleable iron case. They weigh only ten pounds, and are protected from injury by the buffer, which projects further beyond the car than the headlight. They are dust-proof and very bright.

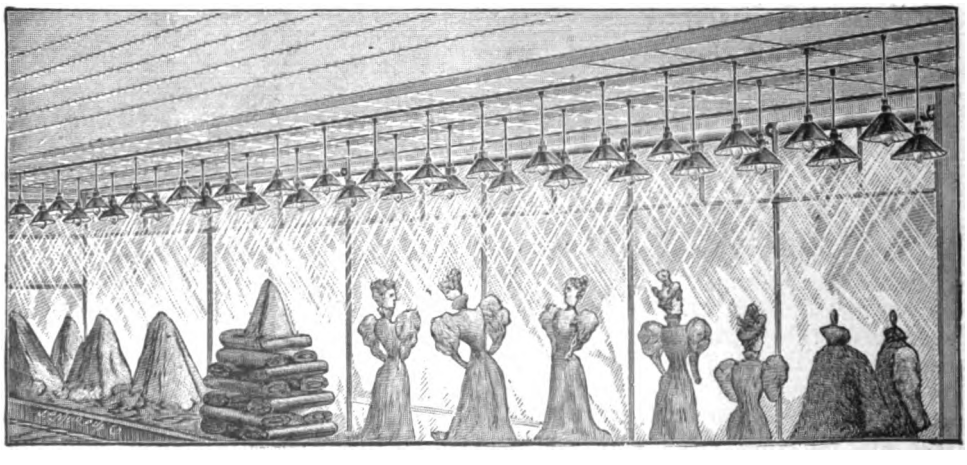
The Columbus Avenue line, of this city, use the Wheeler Reflector Company's oil headlight, fitted with their patent rotating sign, which indicates the route or destination of the car. A knob on the left side of the headlight allows the sign to be changed. The absolute satisfaction its use entails has led to its universal adoption in the United States by street railway and cable companies.

THE ILLUMINATION OF SHOW WINDOWS.

The success of many a store may be traced to its window lighting. The proper illumination of show windows is in part an art and a science. It is an art as regards the degree of illumination required, and a science in its most efficient and effective distribution. There are two methods; the first consists of the use of reflectors on ball and socket brackets, situated as shown in illustration, the lamps placed close to the ceiling illuminating the show windows, yet not appearing in view themselves. Illumination is a great success in this case. The store windows of Jordan, Marsh & Company, R. H. White & Company, etc., utilize this system. The second method, shown in



Example of Show Window Lighting with Wheeler Reflectors.



Example of Show Window Lighting with Wheeler Reflectors.

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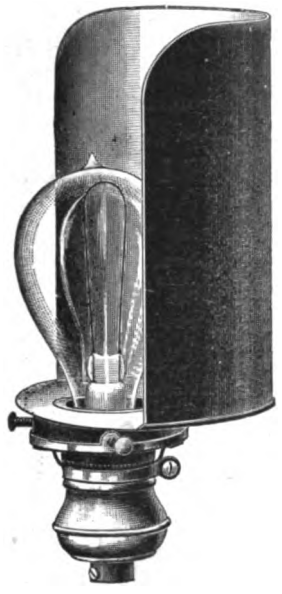
illustration, involves the use of reflectors placed near the ceiling in one row or many. This is very popular with the great majority, limits the cost of installation to a nominal figure and gives great satisfaction. The Wheeler reflector used for this purpose is lined with sixteen converging strips of silver plated mirror glass, as shown in illustration; each one fully reflects the light of the lamp. The illuminating power of the light at the centre is thereby increased fifteen times. These reflectors are made in three sizes, seven, ten and twelve inches in diameter.

The immense satisfaction their use implies can be more thoroughly appreciated by reference to such concerns as Shepard, Norwell & Company, dry goods; H. H. Tuttle & Company, boots and shoes; J. A. Glass & Company, paper hangings, etc., etc. For further reference, address the Wheeler Reflector Co., 24 Washington street, Boston, Mass.



Foot Light.

Oil Head Light with Rotating Signs.

Billiard Table Shade.

Somerville, Tenn.—An electric light plant, to cost $10,000, will be established.

Macon, Ga.—The electric light plant of the Macon Gas Light & Water Company has been purchased by the Macon & Indian Springs Street Railway Company.

Wahoo, Neb.—The power house of the electric light was completely destroyed by fire.

Atlanta, Ga.—The Mayor may be addressed concerning the establishment of a municipal electric light plant

Clarksburg, W. Va.—A movement is on foot to erect an electric light and power plant.

Chattanooga, Tenn.—The Rapid Transit Co. will erect an electric light plant, to be located in Highland Park.

Parabolic Reflector for Dash Board or Vestibule.

Lynchburg, Tenn.—An electric light plant will be established.

Detroit, Mich.—The works of the Michigan Electric Company, dealers and manufacturers of electrical supplies, were greatly damaged by fire on September 24 to the extent of about $50,000.00.

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STREET-RAILWAY SPECIALS.

The electric switch installed at the junction of Flatbush and Third avenues, in Brooklyn, a year ago, by the New York Switch & Crossing Company, has proved such a success that when the company change the curve they intend to put in a new switch of the same make.

The recent tests on the King's County Elevated R. R., of Brooklyn, have been completed and in a month's time the whole system will be operated by electricity on the third-rail system. For the past week thorough tests have been made with a train of five cars headed by a motor car equipped with four 125-H. P. Westinghouse motors, operating on an eight per cent. grade, between Ralph and Reid avenues. These trials have given the highest satisfaction and work is being rapidly pushed to complete the change of motive power from steam to electricity.

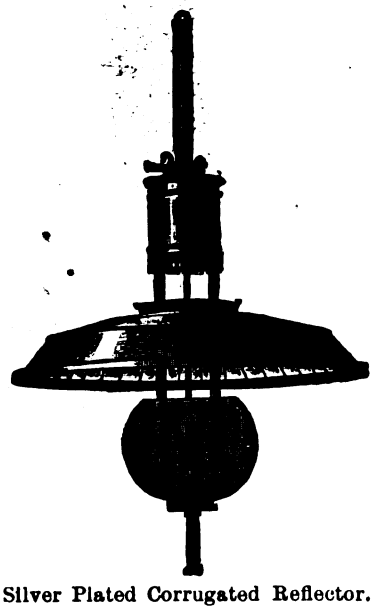
When the Putnam and Halsey Street lines of the Brooklyn Heights R. R. Company were changed from horses to electricity the terminal at Broadway was a deserted spot, composed mainly of vacant lots. For the last five years this neighborhood has improved so rapidly that three years ago the company were forced to extend their lines to Hamburgh avenue. Prior to this there were no streets cut through, no police protection and no street lighting at this point, which really represented the boundary line of Kings and Queens counties. Traffic has so increased in the last few years that the company has decided to extend the line from Hamburg avenue to Ridgewood.

The Third Avenue line of the Brooklyn Heights R. R. Company has suffered considerable inconvenience and blockade through a curve found at the junction of Flatbush and Third avenue. The company never ran anything but small cars on that line, but since the extension of the road to Coney Island the traffic became heavy enough to necessitate the use of new cars with a seating capacity of ninety passengers. These long cars meeting at the curve caused trouble on acconnt of each motorman wanting to go around first. A car in the hands of a green man was certain to cause trouble. This has all been remedied. Last Wednesday evening a large force of men were put to work and a new curve built in ten hours. Cars now pass each other freely and no delay has since then been occasioned.

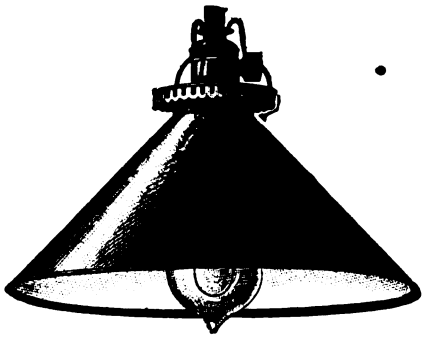
The finest street-car operating on street service is car No. 787 of the Third Avenue line of the Brooklyn Heights R. R. Company. This car was built by J. G. Brill Bros., car builders, of Philadelphia, Pa. It is handsomely finished in ash with bird's-eye maple ceiling, beautifully decorated; seats with reversible backs, caned, numbering eighteen in all, nine on each side, complete the seating equipment. The panels inside are fitted with highly polished French mirrors. The car is fifty feet long, is handsomely painted in orange with terra-cotta panels. It is provided with Brill's double trucks and brakes. Two K-10 G. E. controllers and two No. 1,000 motors of 25-H. P. capacity each. There are running boards on each side of the car. In good weather the windows are let down within the panels, and the panel windows and all are slid up between the ceiling and the roof; the running boards let down and the transformation into an open car is complete. This car is one of the most successful of its kind. It is neither a freak nor is it complicated. It represents the forerunner of an order for fifty which the Brill Company is working hard to finish for the Brooklyn Heights R. R. Company. F. H. Roth.

POSSIBLE INSTALLATIONS.

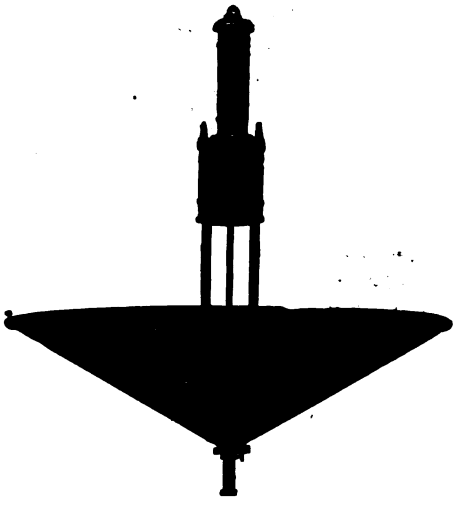
Shelbina, Mo.—The Mayor may be addressed concerning bonds to the amount of $5,000, which have been issued for the purpose of increasing the power of the electric light plant.



Silver Plated Corrugated Reflector.



Incandescent Reflector.



Inverted Arc Lighting Reflector.

Mt. Pleasant, Mich.—A movement is on foot to issue $7,000 bonds for an electric light plant.

Minneapolis, Minn.—F. W. Cappelen, City Engineer, may be addressed concerning the establishment of an electric light plant.

Braddock, Pa.—Steps are being taken to construct a municipal electric light plant.

Perham, Minn.—City Clerk may be addressed concerning establishment of electric light plant.

Fargo, N. D.—E. A. Hughes may be addressed concerning establishment of electric light plant.

Tallahassee, Fla.—The Mayor may be addressed concerning contemplated establishment of electric light plant.

Arlington, Ga.—The Mayor may be addressed concerning establishment of an electric light plant.

Winchester, Va,—William R. Willis may give information concerning contemplated erection of electric light plant.

Cullman, Ala.—Jas. E. Clark is interested in the Cullman Water & Lighting Co., which is being organized to construct water works and electric plant at an estimated cost of $15,000.

Batesville, Ark.—An electric-light plant is to be constructed.

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Jacksonville, Fla.—C. O. Patterson may be addressed concerning extension of electric-light system.

Jackson, Ga.—M. L. Hendrick may be addressed concerning contemplated erection of electric-light plant.

Henderson, Ky.—The mayor may be addressed concerning proposed construction of electric-light plant.

Ellisville, Miss.—An electric-light plant is in contemplation.

Kingwood, W. Va.—U. N. Orr may be addressed concerning the proposed establishment of electric-light plant.

NEW INCORPORATIONS.

Trenton, N. J.—The Trenton-Washington Light Co. has been incorporated by E. Raymond Perrine, New York; Forman H. Gordon, Windsor; Irvin Aaron, Doylestown; George E. Fell, Levi P. Updike, Trenton; to introduce in Trenton a system of lighting and heating. Capital stock, $100,000.

Albany, N. Y.—The Dowd Electrical Co. has been incorporated by Charles Henry Fitch, Pepperell, Mass., and others. Capital stock, $100,000

Chicago, Ill.—The City of Lincoln Gas Co. has been incorporated, to furnish gas and electricity to the city of Lincoln, Ill. Capital stock, $10,000.

Chicago, Ill.—The Chicago Suburban Water & Light Co. has been incorporated by Charles F. Vogel, J. M. Gibson and Charles B. Wood; to deal in water, gas and electricity. Capital stock, $600,000.

Philadelphia, Pa.—The Standard Light and Heat Company has been incorporated by R. M. Robinson, Wm. L. Teter, E. C. Wharton, Henry Robinson, Philadelphia; Joseph W. Irwin, Govanstown, Md. Capital stock, $1,000,000.

New York, N. Y.—Wetmore Electric Co. has been incorporated by George W. Pulver, Jacob Strife, Oliver P. Hedden and Thos. Glenn; to operate in the towns of Lowville, New Bremen and Croghan, and the villages of Lowville and Croghan. Capital stock, $40,000.

Worthington, Ind.—Worthington Water & Light Co. has been incorporated, with a capital stock of $5,000.

Keeseville, N. Y.—Keeseville Electric Co. has been incorporated by Orville S. Morse, H. M. Prime, A. W. Boynton and others. Capital stock, $30,000.

Baltimore, Md.—Electric Gas Light Co. has been incorporated to manufacture and sell machines for the generation of acetylene gas. Capital stock, $10,000.

Indianapolis, Ind.—Indiana Storage Battery Co. has been incorporated by Charles F. Smith, Loren S. Dow and Anthony J. Wilson. Capital stock, $100,000.

NEW YORK ITEMS.

DAVID CHALMERS, manager of the New York office of the Holtzer-Cabot Electric Co., 112 Liberty street, and the only Dave in the electrical trade, is wearing his usual complacent smile as he says that all the trade seems to migrate his way. None of the out-of-town notables of the electrical profession ever fail to pay him a visit when in town, as they consider him to be one of New York's attractions.

H. H. CUTLER, of the Cutler-Hammer Manufacturing Company, Chicago, manufacturers of high-grade rheostats, was in town last week.

J. JONES & SON, 64 Cortlandt street, manufacturers of switches and dealers in electrical supplies, have their works taxed to their utmost capacity in order to keep up with the orders in hand. They have been obliged to add 2,500 square feet more of floor space to their present works for the manufacture of their specialties.

GEORGE GARVIN, of the Garvin Machine Company, Spring and Varick streets, manufacturers of all kinds of machine tools, returned from Europe last week, where he has been looking over the company's large salesrooms in Berlin, Germany, and Paris, France. He also brought some good business back with him and reports the outlook for foreign trade for American manufacturers very bright. The Garvin Machine Company do the largest business among electrical manufacturers in the United States.

STEIN & LANGLOS, of 221 Centre street, manufacturers of all kinds of electrical apparatus and supplies under contract for stock orders, are preparing to bring out a line of special electrical goods which they say will be big sellers. They also do all kinds of machine tools, model and experimental work.

CHARLES J. BOGUE, having removed to larger and more commodious quarters at 215 Centre street, is preparing to bring out a new line of electric-light specialties. He manufactures one of the best photo-engraving lamps and projectors on the market, and does all kinds of armature and commutator-repair work at the lowest figures, commensurate with the best workmanship.

THE GREATEST INTEREST-PAYING BOND in the country is the "Harrington," manufactured by the Harrington Rail Bond Company, 120 Liberty street. They will send a copy of their latest brochure to any one asking for the same and mentioning the "Electrical Age."

ERNEST A. LOWE, the genial manager of J. JONES & SON, has returned to his labors after an extended trip through the White Mountains. He tells some interesting bear and fish tales, but will quickly switch off to other matters, circumstances warranting it.

G. HUERSTEL, president of the International Electric Co , 76 Beekman street, has returned home after an extended business trip. The International Electric Company make a specialty of machine-screw work for binding posts of varied and assorted sizes as may be required, and were the first firm to make a specialty of Ruhmkorff coils for all purposes.

THE STORAGE BATTERY SUPPLY CO., of 239 E. 27th street, lately incorporated, are preparing a line of fine specialties to be used with their storage battery. As there is a great demand for these specialties they ought to prove excellent sellers.

The members and friends of the Alumni Association of the Hebrew Technical Institute are invited to attend an open meeting to be given under the auspices of the above association at the Tuxedo, Madison avenue and 59th street, on Saturday evening, October 1, at eight P. M. Mr. T. Commerford Martin, editor of "The Electrical Engineer," will deliver a lecture on "Edison; His Life and Work." The lecture will consist mainly of personal reminiscences, Mr. Martin having known "The Wizard" for a number of years, and will be illustrated by a large number of interesting lantern slides. If time permits, Mr. Martin will also show a number of lantern slides of Niagara Falls and their recent development for power purposes. Literary and musical exercises will be rendered and a solid evening's enjoyment will be in store for those intending to attend this affair.

TELEPHONE CALLS.

Newton, Kans.—The Newton Telephone Co., A. R. Champlin, manager, has decided to build a long-distance telephone line from this city to Moundridge.

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Hagerstown, Md.—The Maryland Telephone & Telegraph Co. has been incorporated by Col. D. C. Winebrenner, Judge John C. Motter, Wilbur H. Duvall and others; to operate lines in Frederick, Carroll, Howard and other counties. Capital stock, $20,000.

Indianapolis, Ind.—New Telephone Co. has increased its capital stock to $400,000.

Springfield, Ill.—Perry County Telephone Co., DuQuoin, has been incorporated, with a capital stock of $12,000.

Little Rock, Ark.—The American Telegraph & Telephone Co. has been incorporated; to connect Little Rock and Memphis, Tenn., by telephone.

Montezuma, Ga.—The Montezuma Telephone Co. has been incorporated by Jule Felton and Mrs. C. H. Maxwell; for the construction of a telephone exchange. Capital stock, $1,000.

Vine Grove, Ky.—The Winchester & Lexington Telephone Co. has been incorporated by T. C. Vanmeter, David Prewitt and S. D. Goff. Capital stock, $1,560.

West Plains, Mo.—The Mountain Home and West Plains Telephone Co. has been incorporated; to construct a telephone system from Mountain Home to West Plains. Capital stock, $5,000.

Fergus Falls, Minn.—The Fergus Falls Telephone Exchange has been completed.

Hagerstown, Md.—The Cumberland Valley Telephone Co. promoters held meeting recently, and the entire amount of the capital stock, $50,000, was subscribed and ten per cent paid in.

Albany, N. Y.—The Hudson River Telephone Co. has completed an addition to its extensive and complete service.

Bolivar, Mo.—J. C. Pike and H. S. Bruce will establish a telephone system.

Knoxville, Tenn.—The East Tennessee Telephone Co. equipment and franchises mortgaged to the Nashville Trust Co. for $150,000.

Little Rock, Ark.—The American Telephone & Telegraph Co. has received franchise to construct a telephone system.

Cleveland, O.—The Cuyahoga Telephone Co. has been incorporated by E. W. Moore, J. B. Hanna, J. B. Hoge, H. Clark Ford, John Sherwin, H. A. Everett, and H. B. McGrew; to build telephone and telegraph lines in Ohio. Capital stock, $3,000,000.

Salem, Va.—The Interstate Telephone & Telegraph Co. has been granted franchise to construct and operate an exchange.

Lumberton, N. C.—The Robeson County Telephone Co., A. W. McLean president, will construct a long-distance telephone line from Lumberton to Wilmington.

Charlotte, N. C.—J. A. Helvin is constructing a telephone system from Charlotte to Salisbury.

Albany, N. Y.—The American Telephone and Telegraph Co., of New York, has increased its capital stock from $20,000,000 to $25,000,000.

Chicago, Ill.—The American Electric Telephone Co. increased its capital stock from $100,000 to $130,000.

STREET RAILWAY NEWS.

Lansing, Mich.—Capitalists from Detroit contemplate building an electric railway from Lansing to Pine Lake.

Kalamazoo, Mich.—The Battle-Creek Kalamazoo electric line will be built by next spring.

Lawrence, Kans.—An electric street-railway line will probably be constructed in this city.

New York, N. Y.—The Nassau Electric Co. has increased capital stock from $6,000,000 to $15,000,000.

Lansing, Mich.- The Saginaw & Frankenmuth Railway Co. has been incorporated by Henry C. Potter Jr., James B. Peter, Samuel G. Higgins and William J. Bartow; to build an electric road. Capital stock, $50,000.

Dunkirk, Ind.—Dunkirk and Redkey Traction Co. has been incorporated by Henry C. Billingsly, Charles A. Hanable and R. G. Hasbrouck. Capital stock, $75,000.

Sodus Point, N. Y.—Rochester and Sodus Bay Railway Co., incorporated by George E. Merchant, Walter B. Duffy, Thomas J. Nicholl, Daniel G. Clapp, George Wilder and others; to operate by electricity, compressed air or other power, except steam, a railroad line, 41 miles long, from Sodus Point, Wayne County, to Rochester. Capital stock, $1,000,000.

Lansing, Mich.—The Michigan & Indiana Railway Co. has been organized for the purpose of constructing an electric railroad connecting Niles, St. Joseph, Benton Harbor and other southern Michigan towns.

Monticello, Ind. — Tippecanoe Electric Railway Co. has been incorporated by Charles C. Spencer, Emory B. Sellers and others. Capital stock, $50,000.

BUSINESS CHANCES.

Jacksonville, Fla.—The Citizens' Gas Co. have been granted letters patent. They have changed name from the Citizens' Gas and Electric Co. to above name. The liabilities of the company are limited to $100,000.

Grand Rapids, Mich.—The Lowell Electric Light & Power Co. defunct; the creditors have succeeded in having a receiver appointed.

Brantford, Ont.—The directors of the Brantford Electric Light Co. have instructed their manager, Mr. Wyse, to proceed at once to purchase the necessary plant for the extension of the works.

Macon, Ga.—The Macon & Indian Springs Street Railway Company have purchased the electric light plant of the Macon Gas Light & Water Company, and have made arrangements for the erection of additional buildings, to be equipped with an entirely new plant.

Nevada, Mo.—J. B. Quigley & Co. have been granted franchise for the erection of an electric light and gas plant.

Lumberton, N. C.—Steps are being taken to establish an electric light plant in this city.

Houma, La.—Wilson & Jastremski will operate an electric light and power plant.

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WESTON ELECTRICAL INSTRUMENT CO.

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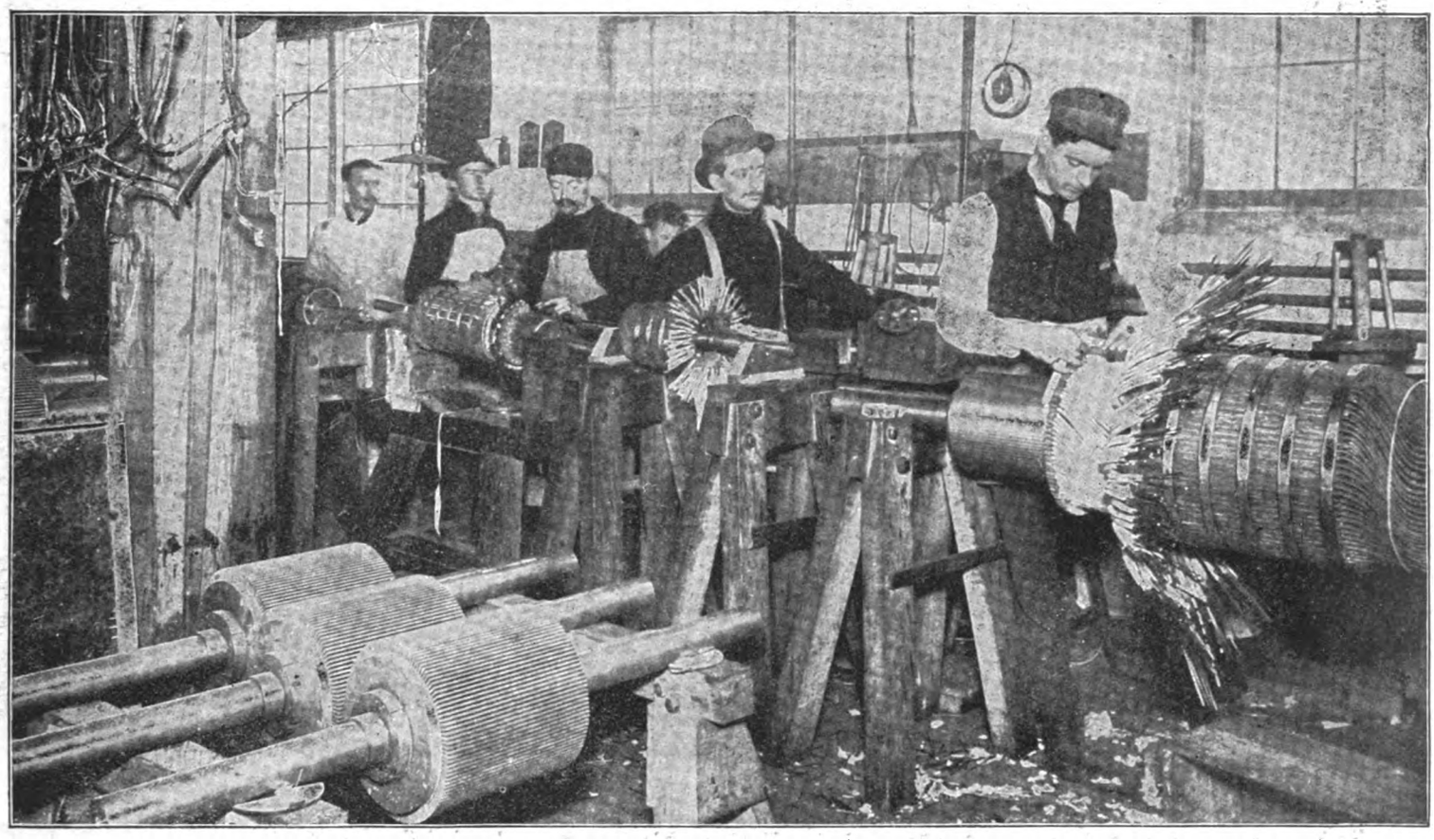
The Electrical Age.

VOL. XXII—No. 14 NEW YORK, OCTOBER 1, 1898 WHOLE No. 594

ELECTRIC LIGHT AND POWER.



Building Armatures. A Corner in Electrical Department.

DIRECT-COUPLED AND BELT-DRIVEN GENERATORS.

The dynamo has become an important factor in civilization. Electric lights have dispelled the slums of large cities. They add comfort to private and public life, and make deserted thoroughfares as safe as busy centres. The design and construction of a modern generator of electric power represents a degree of intelligence and experience in a crystallized form on the part of the builder which shows a deep-seated knowledge of the conditions of practice. The multipolar generator is, in this respect, a living example of the excellence attainable by adherence to the laws of design.

The American Engine Company, of Bound Brook, N. J, whose processes of manufacture in relation to dynamos and motors are thrown open to inspection on these pages, have produced a type of machine of the lightest, most efficient and durable character, from both a mechanical and electrical standpoint. They are constructed with yokes and pole pieces of very mild steel, which, by annealing, possess a high permeability. In adopting mild steel for dynamo construction, Mr. F. H. Ball, mechanical engineer and electrical expert, has obtained a metal whose efficiency, output and weight for the magnetic field produced is practically the superior of any other form of iron. The saving in copper by the use of a highly permeable metal and the reduction in cross-section, weight and floor space make it most desirable for dynamo construction.

The pattern department, in which the wooden shapes are prepared that are reproduced in metal, is commodious and well lighted. It is supplied with every convenience for quickly and thoroughly accomplishing any given work in any way relating to the frame or other parts. The machine shop, in which the castings and other parts are treated prior to assembling, is equipped with all modern conveniences in the line of labor-saving devices. Large planers, shapers, milling machines, engine lathes, drills, etc., assist in the rapid delivery of frames, armatures, shafts, bearings, foundations, etc., to the erecting, testing and winding departments. The lathe department for small work is one of the most complete in the country. The machinists employed there are thoroughly experienced in the details of dynamo construction and understand the meaning of good fitting and careful work. The forging department of the American Engine Company's shops is fitted with a steam hammer striking a six-ton blow at maximum power of delivery. The necessity of having a department of this kind for the renovation of lathe tools and the forging of different accessories is obvious. In a large establishment, such as that comprising these shops, the manager must be fully prepared to rehabilitate machines and renovate such parts as require immediate attention. In fact, the machine shop and forge room go hand in hand as a nucleus from which the assembling, winding, testing and pattern-making departments radiate.

The armatures of the generators have been carefully designed with regard to size, weight, number of turns, maximum temperature rise, etc. They are unique in being iron-clad; the protection thus insured removes an ever-present risk in other types of machines. Over-loading with these armatures does not produce any effects whatsoever within certain limits. The design has been

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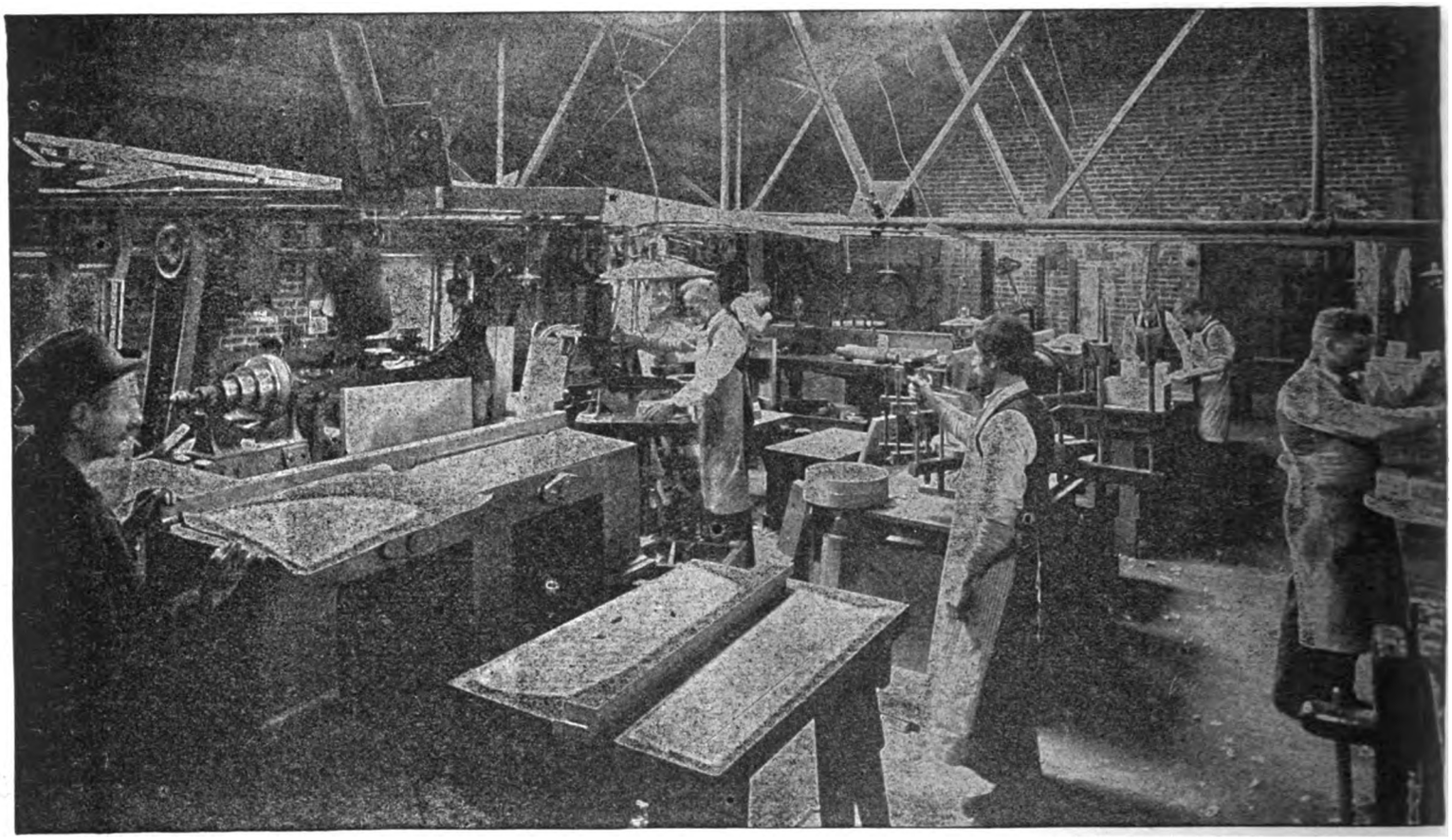
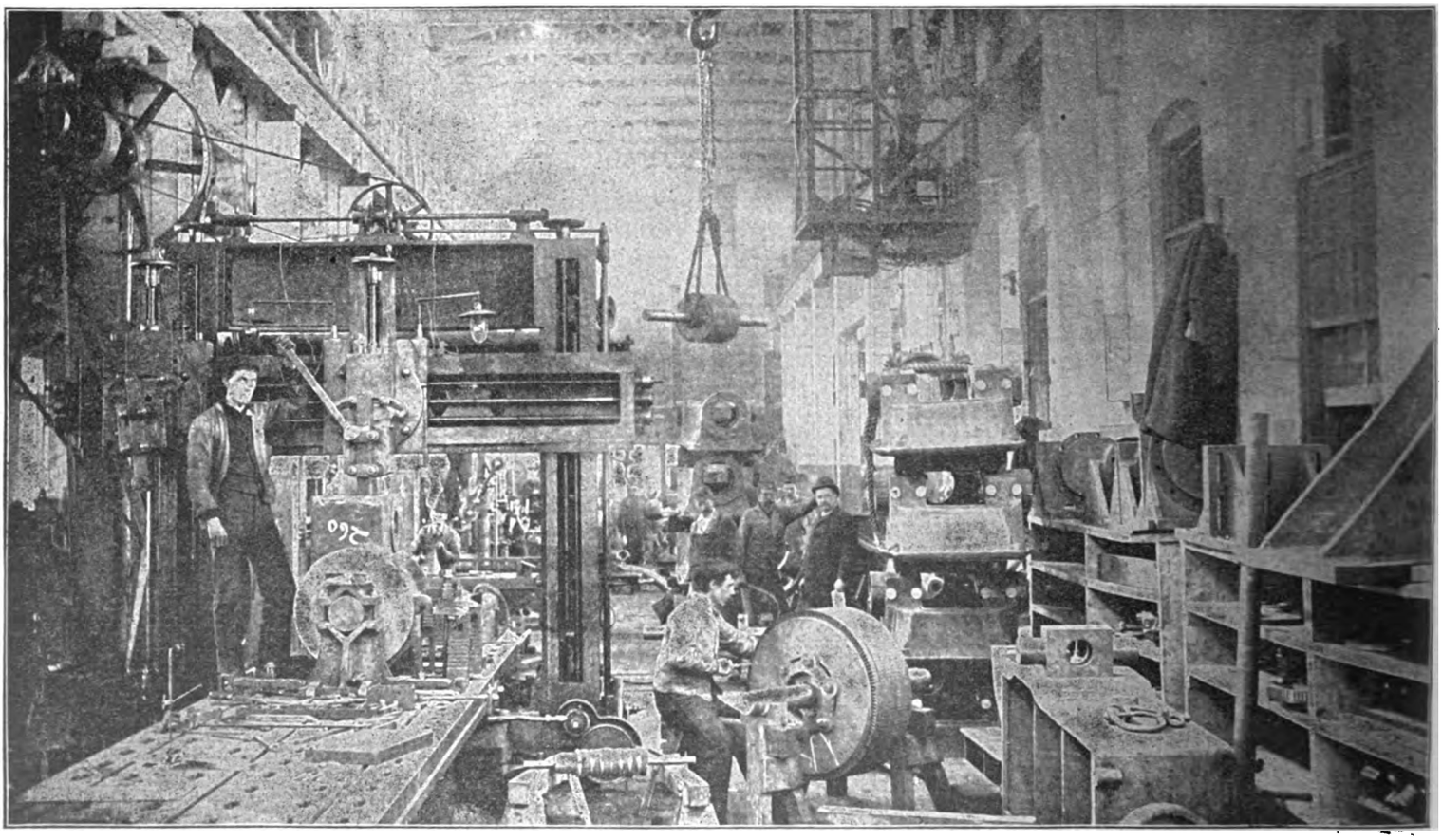
so carefully carried out as regards the possibilities of over-load that a liberal allowance has been made in the size of copper conductors and area of radiating surface to provide a large factor of safety. The design of a dynamo is in reality the design of an armature. Whatever may be the perfection of its other parts, irregularities in the armature will cause a series of ineradicable troubles from the first hour it is assembled and operated.



A Corner in the Pattern Department.



A Corner in the Machine Shop.

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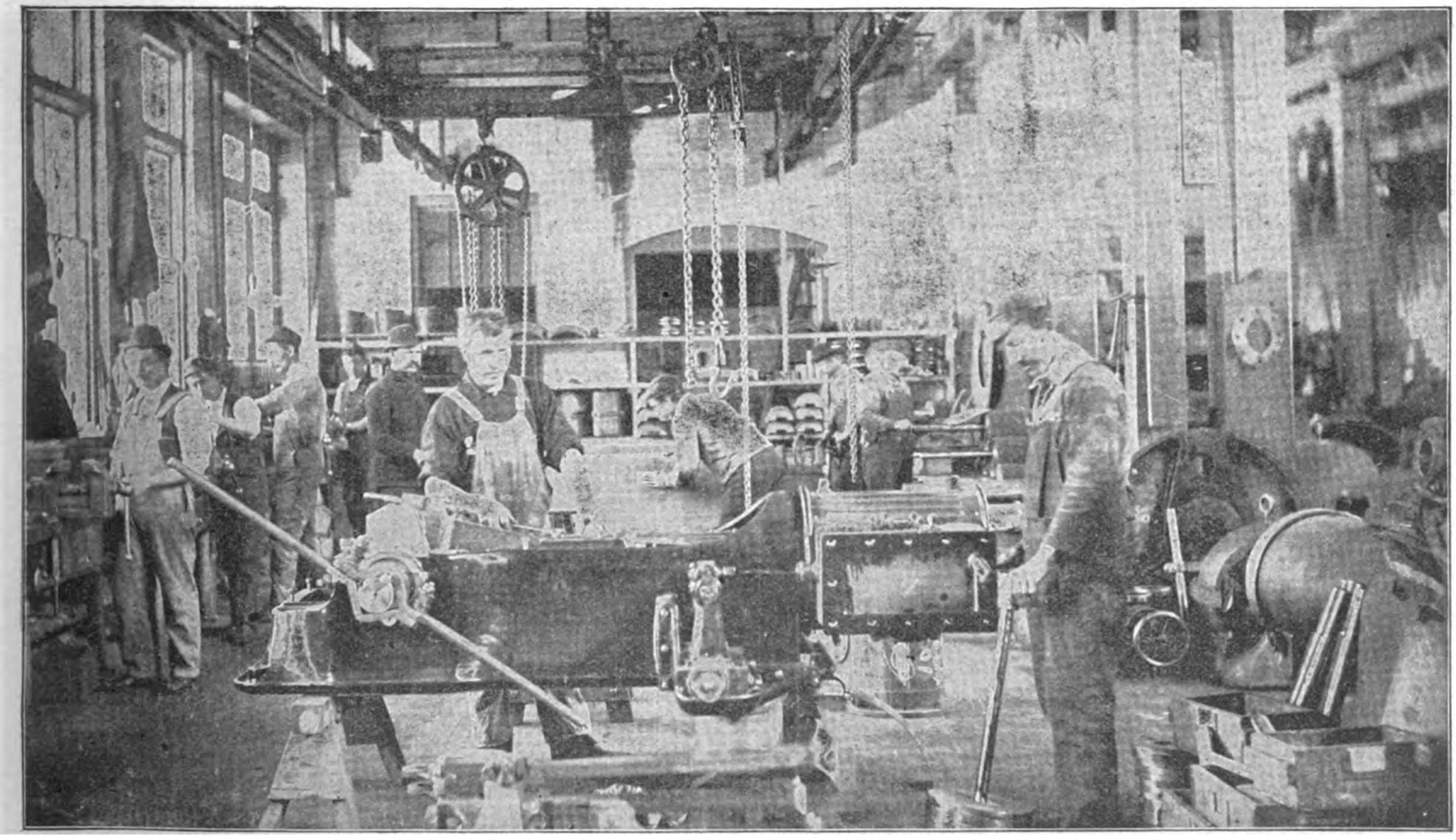
The armatures of the four and six-pole generators are wound with form winding, as shown in illustrations. This system of winding produces results of the most satisfactory nature. Symmetry, compactness and the use of a minimum of wire are among the advantages gained. The dead end wires are reduced to a minimum, and a low-resistance armature results which, experience shows, is essential to success in electric lighting. Considerable

Erecting and Testing of Dynamos and Motors.



Erecting Engines.

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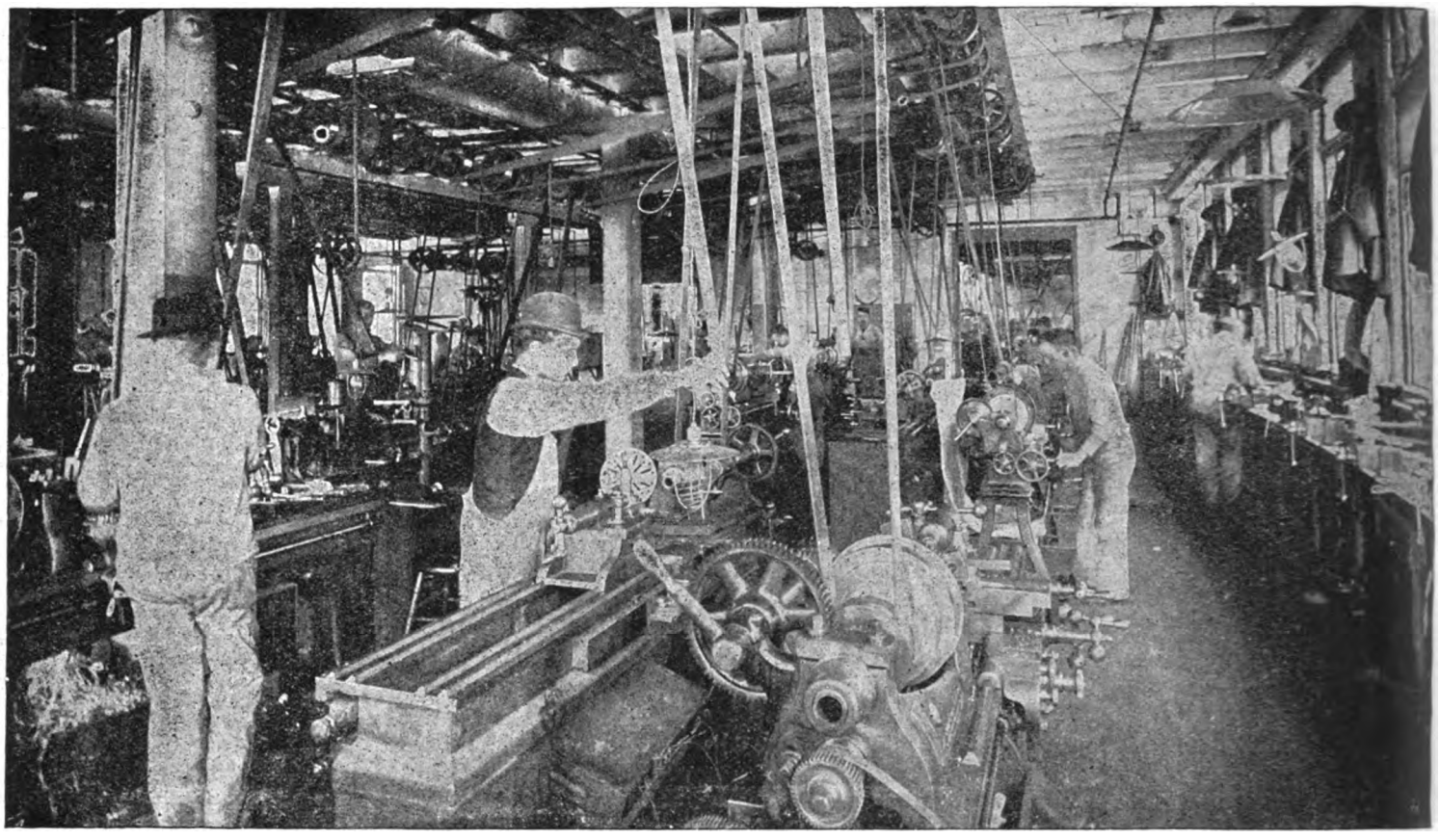
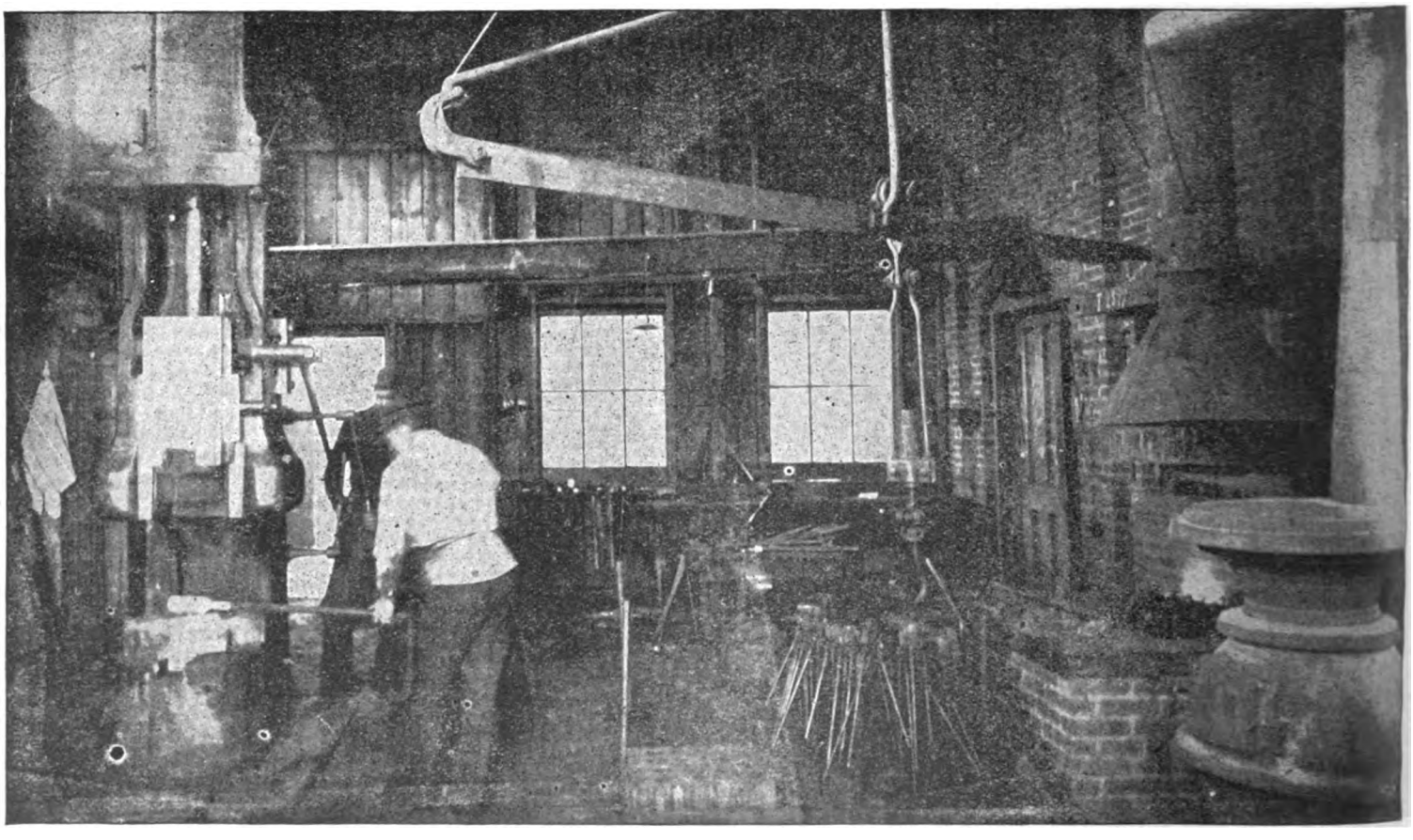
labor is saved in replacing a coil which may be burned or injured. This is, of course, a great feature in dynamo construction, as it recommends a machine with armature thus wound in preference to another. The configuration of these dynamos for belted work and direct connection shows a perfect balance in design. Nothing elaborate has been attempted, but the object kept constantly in view has been the production of a machine simple in construction, high in efficiency, durable, and reliable for long runs.



A Corner in Lathe Department for Small Work.



A Corner in Forging Department Showing Steam Hammer Capable of triking a 12,000 lb. Blow.

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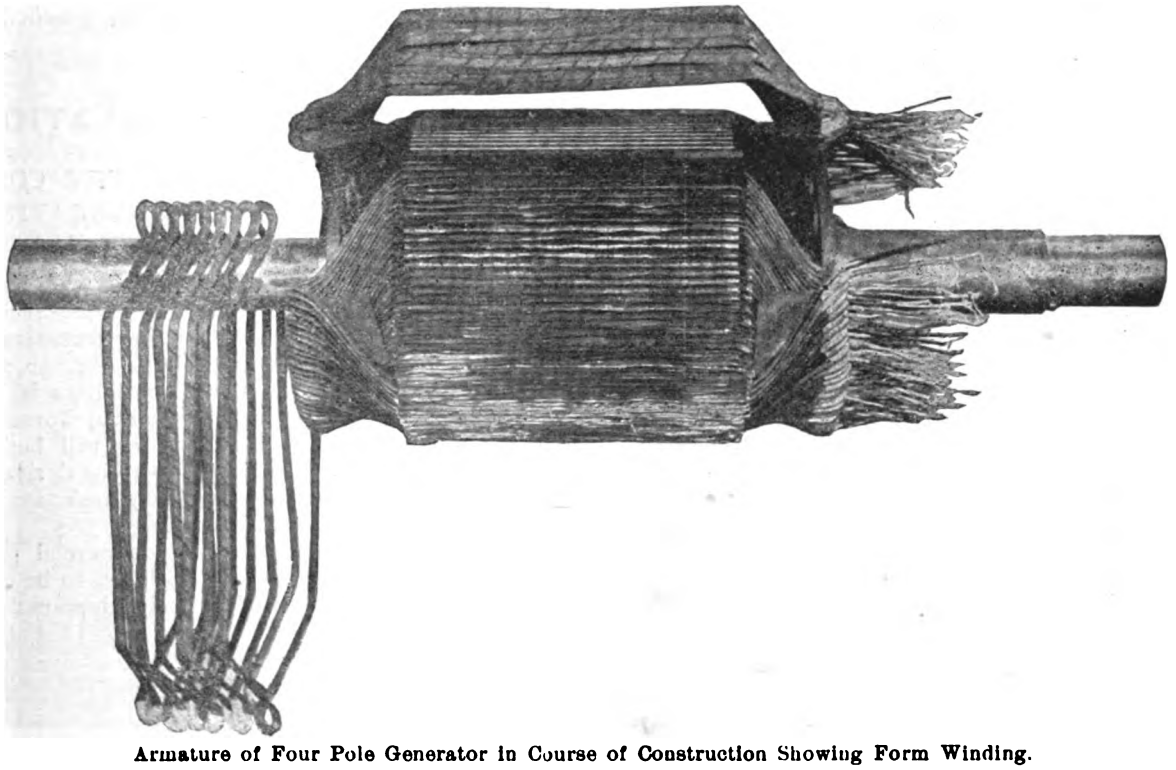
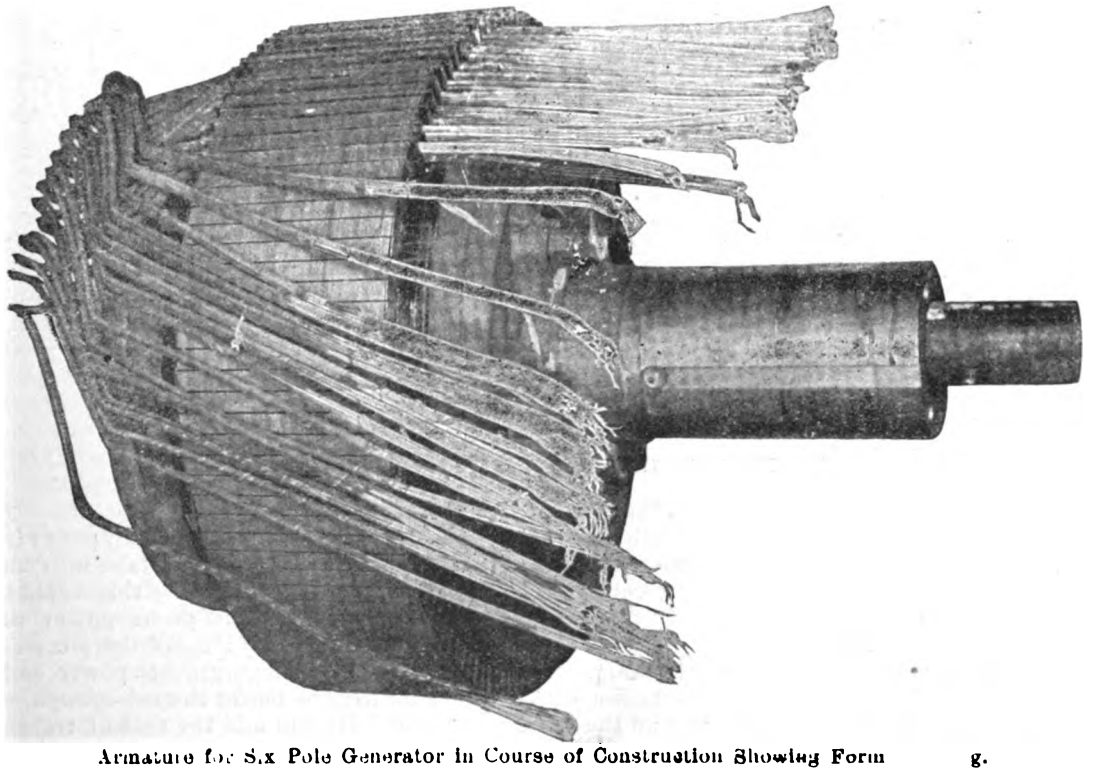
In a machine of this type all that is thoroughly modern and up-to-date has been incorporated, leaving no room for criticism in this respect. Two noticeable features of construction are to be found in the form winding, which



Armature of Four Pole Generator in Course of Construction Showing Form Winding.

insures an effective circulation of air; and the fixed position of the brushes, from which sparking is entirely absent under all conditions of load. The direct connection of these generators to engines, including the building of



Armature for Six Pole Generator in Course of Construction Showing Form g.

the engine, forms part of the work undertaken at this establishment.

The six-pole generator, especially adapted for direct connection, represents the acme of modern practice. From the moment of installation absolutely no attention is required except incidental oiling, etc. The standard four-pole type for belt driving or direct connection runs in sizes from 3 horse power to 125 horse power, and is wound for standard voltages. The standard four-pole type for belt driving runs in sizes of from 2 to 64 K. W. to 100 K. W., the speeds ranging from 1,600 r. p. m. to 425 r. p. m. In the standard six-pole direct-connected generators, with iron-clad cylindrical-drum armatures, the sizes run from 25 to 125 K. W., and the number of revolutions per minute from 400 to 230. This includes sizes of machines rated at 35, 50, 75 and 100 K. W.; the number of lamps that may be lit with each depending upon their watt consumption, the 125 K. W. machine lighting 2,500 50-watt lamps and 1,900 66-watt lamps of 16 candle power.

The American Engine Company have done well to regard the triple alliance of qualities embodied in the three

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terms, *one unit*, *one firm*, and *one responsibility*, as the greatest assurance of success. The purchaser of electrical machinery can inquire further by addressing the above concern at Bound Brook, N. J.

ELECTRIC ILLUMINATING.

The Edison Company, in accord with its declared policy of reducing prices and encouraging the more general consumption of electric current, particularly for long-hour use, will replace its present schedules for both incandescent and arc lighting by the reduced rates scheduled below.

These rates give customers the benefit of the fact that electricity for long-hour use can be produced and sold cheaper than any rival illuminant.

The rates are as follows: For retail use, 20 cents per kilowatt hour (equivalent to 1 cent per 16 candle power 50 watt incandescent lamp hour, or 10 cents per standard arc lamp hour) for first hour's average daily use of the total lamp equivalent connected; 15 cents (¾ cent or 7½ cents) for the second hour; 10 cents (½ cent or 5 cents) for the third and fourth hours; and 5 cents (¼ cent or 2½ cents) for all use above four hours.

For wholesale use, with a guarantee of 2,000 kilowatt hours consumption each month and two hours average daily use of installation, 10 cents per kilowatt hour for the first four hours' average daily use and 5 cents for all use above four hours; or, at the option of the consumer, the present wholesale or kilowatt rate of 10, 9, 8 and 7 cents per kilowatt hour for 2, 4, 6 and 8 hours' average daily use, with reductions for quantity, etc.

These prices cover both incandescent and arc lighting, and include renewal of incandescent lamps (not exceeding one 16 c. p. lamp for each 20 kilowatt hours), and the carbons and trimmings for arc lamps, but not first supply of lamps.

To encourage cooking, heating, etc., by electricity, household apparatus for cooking, heating and ventilating will, until further notice, be excluded in reckoning installation.

Natchez, Miss.—The city wants bids on the erection and equipment of an electrical plant.

FLASHES.

Tucson, Ariz.—The Western Union Telegraph office burned.

Allegheny, Pa.—New machinery is being added to the Allegheny City electric light plant.

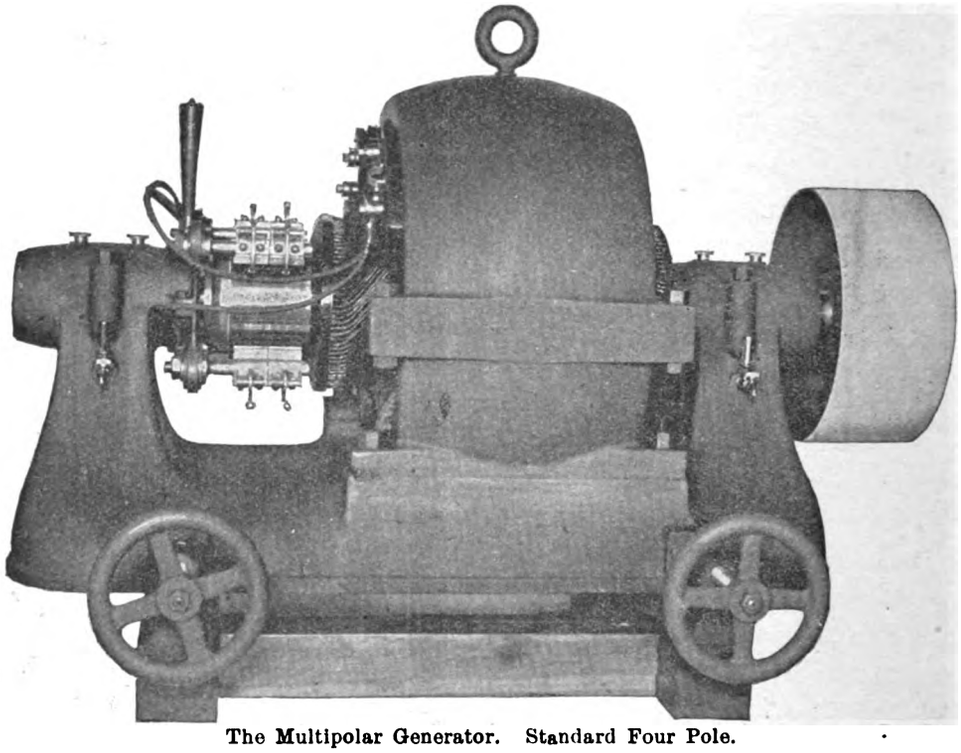
WATER POWER INSTALLATIONS.

LACHINE RAPIDS PLANT AND THE COST OF PRODUCING POWER FOR GENERATING ELECTRICITY THEREFROM.

By W. McLea Walbank.

In our own case you will notice it was necessary for us to spend about one million dollars ($1,000,000) in hydraulic development. This million dollars is able to furnish us over twenty thousand (20,000) horse power, whereas it will be some time before we will be able to convince the public of the advantages to be derived from the use of electricity, which is no easy task, as anyone familiar with the subject will bear out.

The 5,000 horse power, from a commercial point of view, will have, for the present at least, to be charged with all the expense of the hydraulic development of over 20,000 horse power.



The Multipolar Generator. Standard Four Pole.

In estimating the cost of producing power from the Lachine Rapids, the writer does not take into consideration the cost of distributing power, for this would be the same in either case, whether the prime mover was a water wheel or a steam engine. He will therefore confine himself to the cost of developing water power and delivering that power on the bus-bar at the sub-station, exclusive of the generator. He will add the cost of transmission line from the source of power to the sub-station in the city, because this is directly attributable to water power plants, as it would not be necessary in the case of a steam plant, unless it were for transmitting power from a coal mine to a city, or following the practice laid down by the Brooklyn Edison Company, in locating their power house at a point convenient for obtaining coal and water at reduced prices, using high-tension transmission and converting by rotary converters at various sub-stations.

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THE WEALTH INVESTED IN ELECTRICAL ENTERPRISES IN THE UNITED STATES.

The most important department of electrical engineering at the close of this century is electric railroading. Not more than ten years ago it hardly owned an existence. The total value of the investments in electric railways, in electric light and power companies and in the manufacture of electric appliances, including telegraph and telephone systems, amounts to $2,000,000,000.00. Of this enormous sum about one billion dollars is invested in street railways; one half a billion in electric lighting, and the balance of half a billion in telegraph, telephone, power transmission and other minor fields of work requiring the use of electricity. It is quite certain that there will be an increase of five hundred million dollars more to the total representing electrical investments when electricity finds its way to the private homes, side streets and slums of large cities; when electric lights are used by the general public in place of gas, and electric heating has ceased to be a novelty, but has been accepted by those living in great cities as a necessary adjunct to home comfort.

An estimate of the real value of electrical investments is a practical impossibility on account of the rapid changes occurring in the fields of applied science. Yet taking today with its wealth representing electrical investments as a foundation, the two billion dollars may increase to four or five, or even six, in ten years to come. A calculation based upon known quantities would give only a natural rate of increase, but in vast commercial problems unexpected inventions may double, triple or quadruple the sum invested. The past proves this. Why should we not expect it in the future? There are hundreds of inventions still inchoate, some in the hands of large corporations which will be developed, others whose date of development is indefinite for want of capital. The unknown factors certainly call for consideration and an estimate of the value of electrical enterprises might far exceed the two billions of dollars given as a conservative valuation. When the steam railroads have taken to electricity, and trucks and city vehicles are animated by it, and all homes are lighted and heated by its silent force, the wildest estimate of today may be the most conservative at that period of progress.

ELECTRICITY IN SHIPYARDS.

In large shipyards it is a common practice to drive the heavier machines by separate steam engines. These engines are of the non-condensing type and very wasteful. The tools that are driven by them are punching machines, heavy shears, large rollers, drills, etc. The coal consumption in a steam plant driving a collection of small steam engines is very great in comparison with the work done. Of late the adoption of electric power has shown more than ever before its peculiar fitness for this work. The lightness of the motor and the flexibility of an electric system are elements in favor of such an installation that none can gainsay.

Each individual machine may perform its functions when all are driven by electricity with an efficiency, speed and neatness that commends it at once for practical purposes. The electrical manufacturer is paying more and more attention of late to the design and construction of this class of tools. They are merely motors direct-connected to boring, planing, reaming, punching machinery, etc., yet are particularly interesting through the service they perform and the saving due to their employment. A large boiler operating a group of small steam engines will never begin to have the efficiency of an electric plant supplying a system of motors driving special tools.

The most useful of all motor-driven tools used in ship building is the counter-sinking machine. Then comes the boring and punching machine. By employing a portable milling machine driven by a motor the cutting of keyways in shafts, which used to take more than a day, is now accomplished in two hours. This, as a specific example, utterly opposes the idea that, because the first cost of an electric system is greater than a steam equipment, such a system must not be utilized. This is a mistake from every standpoint; the actual cost of installing a machine tool with motor attached cannot be greater than that of the same machine tool with steam engine attached. The difference cannot be found here. It cannot be found in the mains, as they are certainly cheaper to lay than steam pipes of the same length. But the difference in cost may be traced to the use of a dynamo and engine which are used between the boiler and electrically driven tools.

The time saved in using electric tools will in less than a year in a busy shipyard compensate for the cost of dynamo and engine; and during the second and third years of use accumulate a profit for the investor. For numerous purposes, unique in themselves, direct-connected tools and machines connected with shipyard work have proven superior to any other form of driving machinery installed in their place; in England electric capstans are in use, and electric elevators, or lifts, as they are commonly termed, built adjacent to a ship's sides while it is undergoing construction.

From a financial standpoint the saving due to a well installed electric system makes it highly commendable, and the industrial and commercial practice and experience speak highly in its favor.

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There will also be included the step-down transformers to bring the pressure equal to that required for local distribution, namely, in the neighborhood of 2,000 volts.

He will also charge the water power with the drop or loss in power from the rapids to the sub-station.

The writer therefore considers, in justice to the Lachine Rapids plant, it would be necessary to give, first, the cost per kilowatt per year for the portion of the plant at present installed and connected to generators ready for operation, and, second, what the cost will be per kilowatt per year when the whole water power development is in operation.

First—The total cost of water rights, dams, hydraulic machinery, power house, transmission line, step-down transformers, etc., is $957,200.

Power developed, 4,000 kilowatts at the generator. Allowing 10 per cent loss, there will be delivered at the sub-station bus-bar 3,600 kilowatts, which is equivalent to $263.83 per kilowatt, capital cost.

This, at 6 per cent., would be equivalent to	$15.95 per K. W.
Depreciation of $300,000, which will more than cover the cost of that portion of the plant subject to depreciation, rated at 5 per cent. and spread over 3,600 kilowatts, would be equivalent to	4.17 per K. W.
Operating expenses, including labor, repairs, insurance, amounts to $10,275 per annum, which, divided into 3,600 kilowatts, is equivalent to	2.85 per K. W.
Making a total cost per kilowatt on a twenty-four hour day basis, per year	$22.97 per K. W.

Second—The total cost per kilowatt with the whole water power plant in operation.

Before giving these figures the writer would like to explain that the figures herewith quoted are reliable for the cost of the completed plant, inasmuch as the same is at present under contract with reputable firms, the Lachine Rapids Hydraulic & Land Company having a limited time in which to order the works completed.

The total capital cost with seventy-two wheels installed will be $1,113,273.

Power developed after deducting all losses will be 13,500 kilowatts at the sub-station bus-bar, equivalent to $82.46 per horse power capital cost, which, at 6 per cent., represents (per annum)	$4.95 per K. W.
Depreciation per kilowatt will equal	1.68 per K. W.
Operating expenses, including labor, repairs, oil and waste and insurance, if taken upon the same basis as already existing, will amount to $20,453, equivalent to	1.51 per K. W.
Making a total for a twenty-four hour run per annum of	$8.14 per K. W.

It will be noticed that the operating expenses, as well as the depreciation per kilowatt, in the latter case is very much reduced, and it is a remarkable feature how constant our operating expenses are, even at present, being practically the same with full load as with no load.

In connection with these figures it might be stated that coal used in Montreal and vicinity is what is known as Nova Scotian coal and costs $3.50 per ton for run of mine.

The writer would also draw your attention to the fact that the capital cost cited in each of the foregoing cases includes money paid for real estate, of which the company owns over some eight million feet, fronting on the rapids, intended at some future date to form the site of a suburban town, and which it is hoped and expected will return the money expended in developing the water power above referred to.

Conclusions.

From the foregoing the writer trusts that he has shown that where reliable water power can be obtained within reasonable distance from power centres it can be made to produce cheap electric current, to say nothing of the great advantages the city must derive therefrom, not only commercially, but viewed from a sanitary standpoint as well, as the use of electric power thus generated is the best smoke consumer yet invented.

NOTES FROM DISCUSSION OF PAPER.

In the discussion it was stated that the cost given in the paper was based upon the possible output of the plant, independent of the number of hours it was used. The capital stock was a certain amount and there was a certain capacity in electrical generators, and by dividing one into the other, you would get the amount it cost per horse-power. They would sell power, Mr. Walbank said, to anyone who wanted it, no matter for how short a time.

Mr. Ferguson said that to offer a comparison between a water-power station and steam plant, he would offer some figures based on the Harrison-street station of the Chicago Edison Co. The cost of station, including the transmission line, was $1,200,000; the interest on that amount would be $72,000; total cost of operating at the switchboard of that station $77,000 per year; the two latter items added together making $149,000. Taking the depreciation that Mr. Walbank gives, we have a depreciation of $20,000, making the total operating cost $169,000. The total maximum capacity of that station is 7,000 kilowatts, so that the cost per kilowatt in that station would be $24, as compared with $22.90, as stated by Mr. Walbank; so that the difference in cost in generation of a water plant and that of a first-class steam plant is very light. Coal in Chicago is $1.12 per ton.

Mr. Walbank stated that his coal charge was $3.50 a ton.

Mr. Ferguson said that it should be known what the load factor of Mr. Walbank's station was, because the figure of $10,000 is proportional with the output, or it will vary with the output, so that the load factor is now only ten per cent. It was hardly fair to compare the cost he had presented with a system having a load factor of 25 per cent. If it cost only ten per cent., then, of course, the output per kilowatt would be less, and the figures would be still more favorable to the steam plant.

The next paper was on "Transformer Economy," by Professor Goldsborough, of Purdue University, Lafayette, Indiana.

Previous to the discussion on this paper the President appointed the following gentlemen as the Committee on Nominations — A. M. Robertson, Minneapolis, Minn.; James Dee, Houghton, Mich.; James I. Ayer, Boston, Mass.

ALTERNATING CURRENT MACHINERY.

"TRANSFORMER ECONOMY."

By Professor Goldsborough, of Purdue University, Lafayette, Indiana.

Continued.

The ageing of transformer iron does not increase at a constant rate with the time. The rate of increase diminishes as the service continues, but the increase may go on indefinitely. Until the use of non-ageing iron becomes more generally possible than at present, it is prob-

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able that it will pay to replace the majority of the transformers placed on the market by new ones every few years.

It is our present intention to inaugurate next fall a series of one-year ageing tests under continuous full-load conditions of a representative number of transformers that will be built during the present summer by the manufacturing companies who are interested in having these points thoroughly ventilated, and I trust to be able to publish a record of fine performance in this respect at the time of the completion of the tests.

The correct insulation of transformers is another important point that should be considered by the central station manager. Like many of the problems with which we have to deal in the effort to make the transformer a commercial success, this one seems to be subject to a wide variety of opinion. The oil insulation of transformers has deservedly come into great favor, and where care is taken in the selection of the oils used and in the proper design of the transformer case, high protection is secured. Oil insulation under all circumstances does not, however, secure to the purchaser the protection which he feels he is paying for. The claims that are usually made for the superiority of oil insulation, to wit, that it serves to preserve the insulation from oxidation, reinforces the resistance of the insulation to puncture, reinsulates punctures after the passage of the discharge and facilitates the diffusion of the energy liberated as heat in the core and coils, can in general be readily substantiated.

My experience, however, is that these statements must be regarded as having only a relative bearing upon the subject. Under certain circumstances the insulating value of an oil will be very materially impaired. We are told that transformers will last indefinitely when insulated with oil, whereas without oil the insulation will be so deteriorated after five or ten years that the transformers should be replaced, and it may therefore be a matter of surprise that the insulating qualities of the oil itself are ever seriously diminished. As a matter of fact, experiment shows that the insulating properties of the oils commonly used in transformers are increased, as their temperatures are raised up to about 110 degrees C., and that if allowed to cool they will not lose their augmented power of resisting a disruptive discharge.

This much might be said in favor of oil insulation, in view of this two or three-fold gain in insulating power, were it not for the fact that a continued heating of the oil for any considerable length of time changes the oil to such an extent that on being cooled its break-down value will be only about one-fifth of its original value. And therefore an oil-insulated transformer that will stand an insulation test of 10,000 volts when new, may break down under a pressure of 2,000 volts after having been in continuous service for a considerable time. Conditions such as will produce a result of this character are not likely to occur in the case of modern transformers, as the increase in the temperature of even the poorest transformers rarely exceeds 70 degrees C. I have, however, met with cases in which excessive heating has resulted when the transformers were kept continuously in service, and I have also in mind a case in which a good modern transformer was so situated above a tin roof and in a position where it was protected from any breeze that might be stirring, that, when the sun played upon it, its temperature reached perfectly distressing values.

What I have said will serve as a hint of how not to handle a transformer, and the importance of selecting proper places for the location of transformers.

If you will look carefully into the matter you will find that not all of the burnouts are due to faulty construction on the part of the manufacturer. It is my experience that the contractor has been in fault in a fair proportion of the cases in which the transformer and service installation has suffered.

For all commercial purposes the best oils will be found to give thoroughly satisfactory results and retain their insulating properties unimpaired so long as the maximum temperature of the oil does not exceed sixty or seventy degrees centigrade. In making a station test of a transformer, if the rise in the temperature of the windings, as measured by the increase of resistance method, does not exceed fifty degrees centigrade, after a ten hours' run at full load, the transformer may be passed as satisfactory in this respect.

In connection with oil insulation it must be remembered that its efficiency as an insulating medium is impaired by discharges in the oil. One of the foremost claims made in behalf of oil insulation is that it will flow in and fill up a rupture in the insulation of the coils. Every electric discharge that takes place through the oil, however, disintegrates and breaks up the normal structure of the oil, and causes carbon and other conducting compounds to form. These will rapidly multiply if the discharges are at all frequent, and will destroy the insulating properties of the oil.

As a case in point, and I presume you may know of other similar instances, I want to call your attention to a very good example of what good practice vs. bad practice will accomplish.

There is a city in the West in which the conditions under which electricity is supplied for incandescent lighting are somewhat unusual. There are two companies interested in the business, and both employ the alternating-current converter system of distribution. The plant that is operated by the older company was installed about six years ago, and its equipment has grown slowly from year to year as business expanded. Its development has followed the waves of evolution modifying electric lighting practice within this period with a lag factor approximating 90 degrees. The plant has some strictly modern machinery, but much of the line equipment is old. A number of its transformers have been burnt out on account of defective insulation, some have been burnt out by lightning, and some have shown their efficiency by getting so hot when switched in on an all-day schedule under light load, that the "oil used to insulate them boiled up and over and ran down the outsides of the cases."

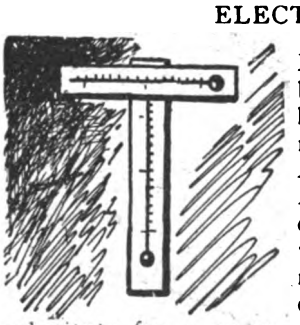
It is needless to say that in the latter type of transformer the hysteretic losses were considerable; the transformers were, however, manufactured by a firm of high commercial standing.

The lines of the old company are not protected by lightning arresters except where they enter the station, and the secondaries are not grounded.

(To be continued.)

ELECTRIC PUMPING MACHINERY.

ELECTRIC PUMPS.



THE manufacture of pumps dates back to a very early period in history. To avoid the labor of raising water to a given height, Archimedes invented his spiral. A pipe of helical shape, with one end dipping into the water, the whole inclined in position and rotated, performed the function of a pump. But there is no real substitute for a pump, and in the use of one, unless a critical selection is made, power may be wasted and many difficulties experienced. The pump is a purely mechanical device, but its efficiency and smoothness of operation are two features which must never be lost sight of during their construction.

The Worthington pumps are known all over the world for their success, durability and finish. In connection with a motor, the application of electricity practically per-

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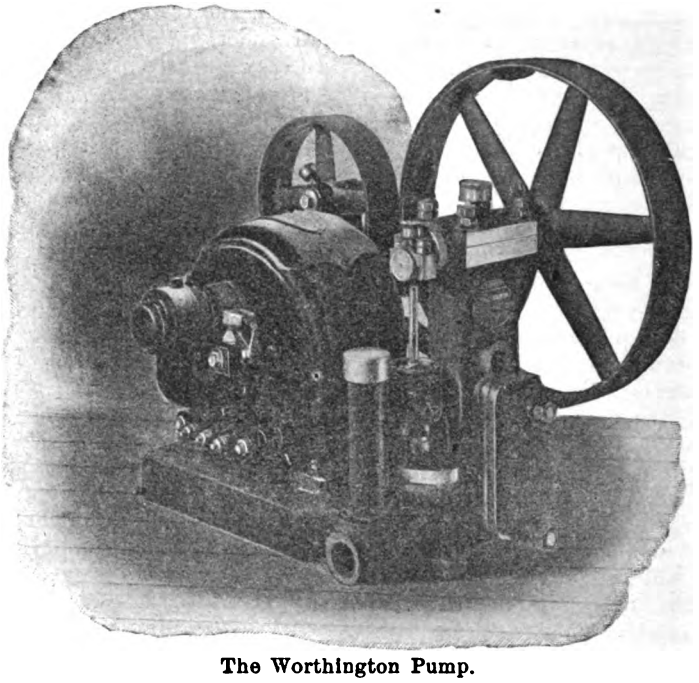
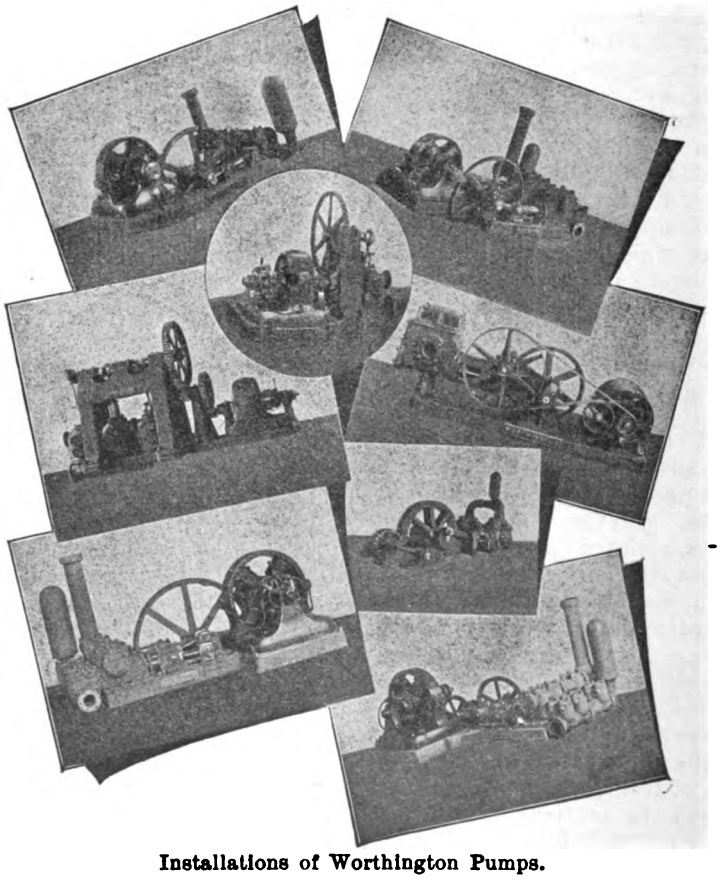
fects an appliance to a degree hitherto unreached. The Worthington electric pump is used for many purposes, including the filling of house tanks, the reservoir tanks of office buildings and such purposes where the raising of water to a higher level is to be quickly and coveniently accomplished. These pumps are made in two sizes, one of 500 gallons' capacity per hour, the other of 250 gallons' capacity per hour. The motor is not connected to the pump by gearing, but is belted to it. Noise is therefore absent while the pump is operating. The mechanism of the pump is such that the plunger, which is differential in action, operates equally well on the up and down stroke. The pump shaft is driven at the rate of 200 revolutions per minute, and in consequence of this the flow of water is uniform and regular. The power consumption, depending upon the work done, reaches a maximum of one horse power and a minimum of one-quarter horse power. The differential plunger of this pump gives the motor steady work. It therefore operates under the best conditions, and the pump, as a whole, represents, from an economical standpoint, one of the best combinations on the market.



The Worthington Pump.

The Worthington electric pumps are manufactured by Henry R. Worthington, at Van Brunt and Rapelyea streets, Brooklyn, N. Y. Offices and agencies have been established in all the principal cities of the world, as well as of the United States.



Installations of Worthington Pumps.

The demand for electric pumps has become so heavy

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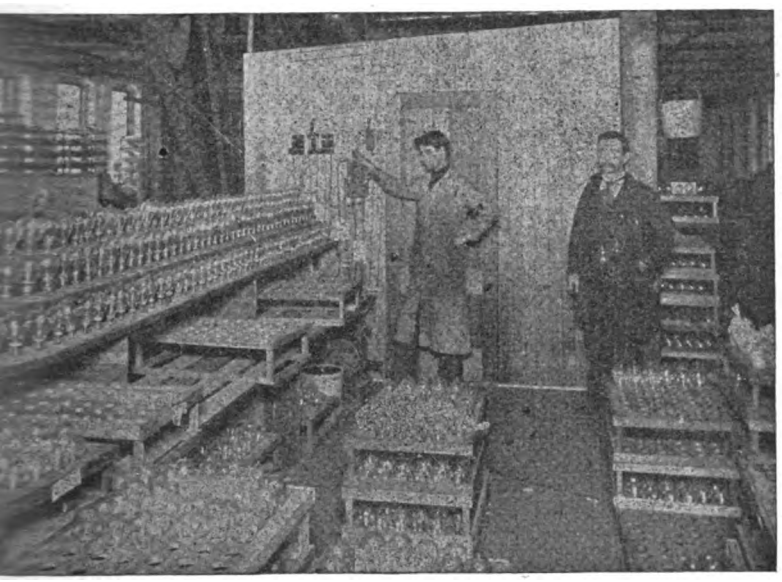
within the last few years that it is recognized to-day as a field of work distinct in itself and of increasing importance.

STRAY CURRENTS.

The cost of extra fuel required to light a train of ten cars by an English system of dynamos driven from the axles of the cars at ordinary speeds is one-half pound per train mile, according to the "Railroad Gazette."

Mr. S. N. Fleming, a locomotive engineer at Hopkinsville, Ky, has patented an electric train-blocking system of rather peculiar character. He proposes having all



Lynn Incandescent Lamp Co. Testing Lamps Before Shipping.

locomotives equipped with a magetic bell, electric battery and two trolleys, which make contact with a third rail. One merit claimed for this system is that the locomotive engineers miles apart can signal to each other.—Ex.

Aluminum conductors are used for the first time in long-distance electric transmission in carrying the current from the Snoqualmie power plant to Tacoma and Seattle. The line to Tacoma is 47 miles long, and Seattle is reached by a 12-mile branch. The wires are Nos. 2 and 3 B. & S., the composition being aluminum 99.3 per cent., iron 0.25 per cent., silver 0.3 per cent., and this metal alloyed with 1.5 per cent. of Lake copper.—Exchange.

In regard to the competition of electric lines, President Tuttle, of the Boston & Maine, believes that the steam roads will have to bow to the inevitable and surrender a portion of their suburban traffic. No matter, he says, how the matter may be viewed, the street railway within certain limits has now and will continue to have the advantage over the steam roads. The latter may improve their service as much as they can, but they will find eventually that they cannot compete with the trolley lines, which insure service that the steam roads cannot give, and the latter will therefore have to abandon suburban business within four or five miles of the city. They will have to develop their long-distance service, and can make improvements within a zone of from six to twenty-five miles, in addition to lowering the longer distance rates. In this way suburbs will be extended.—Ex.

Travellers are soon to be carried to the top of the great St. Bernard by electric power. Power will be taken from the numerous mountain streams of the great St. Bernard. The enterprise is backed by English capital.—Ex.

The longest span of telegraph wire in the world is said to be in India, across the river Kistna. It is over 6,000 feet in length.

BUSINESS CHANCES.

Albany, N. Y.—The American Telephone and Telephone Company, of New York City, increase of capital stock from $20,000,000 to $25,000,000.

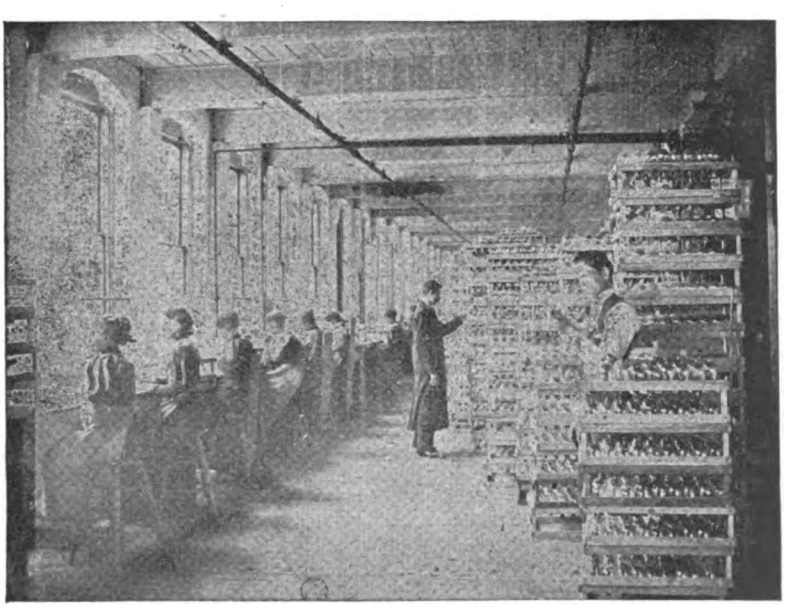
Albany, N. Y.—The Commercial Cable & Telegraph Company, capital increased from $100,000 to $500,000. The debts and liabilities of the company amount to $15,000,000.

INCANDESCENT LAMP MANUFACTURE.

STREET-RAILWAY LAMPS.

The severest test possible for an incandescent lamp may be found in street railway service. A new railway lamp has been perfected by the Lynn Incandescent Lamp Company, of Lynn, Mass. The strength of the filament, uniformity of light and efficiency of this lamp make it of the utmost importance to street railway companies. The current consumption of this lamp is a fixed quantity. By securing this feature of manufacture these lamps, when in service and connected in series, burn equally well. It is simply a matter of experiment for street railway concerns to discover the superior qualities of this lamp. Its long life and power of throwing light equally in all directions is earning for it a national reputation.

The Lynn Incandescent Lamp Company make a specialty of renewing burned-out lamps. This unique industry is of great advantage to consumers of incandescent lamps. By paying a nominal sum, the filaments of old lamps are replaced by new ones and the bulb and base cleaned as well as new. The requirements of pressure, candle power and wattage are carefully observed. The annual expense to large electric light companies, street railway corporations and private plant owners amounts to hundreds of thousands of dollars for lamps. A considerable percentage of this expense is saved by renewing them on the plan offered by this company. This can be ascertained by writing for price lists and literature bearing on the subject.



Lynn Incandescent Lamp Co. Room Where the New Carbons are Put Into the Bulbs.

The extensive plant and complete equipment of the Lynn Incandescent Lamp Company enables them to operate commercially under the best conditions. They have not confined their work to any rut, but are broadening it. They make a very serviceable and successful 220-volt lamp, and in other respects have made progress in this

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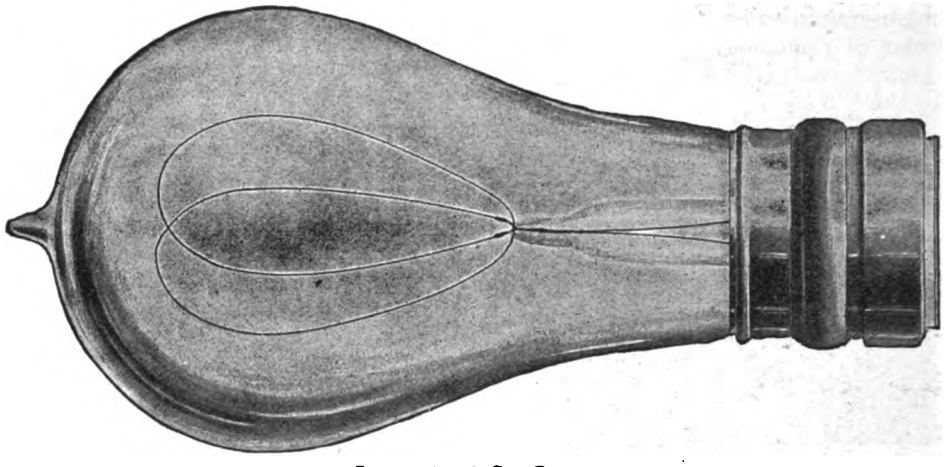
particular field of work. One of the direct proofs of their enterprise lies in the fact that they are the first to renew burned or deteriorated lamps. They also sell a renewed railway lamp which is only half as expensive as the new lamp above described.



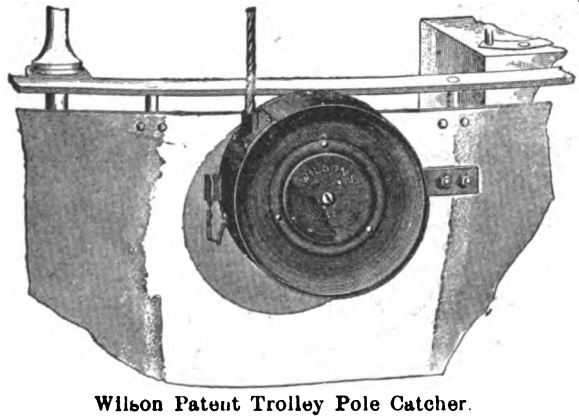
Lynn Street Car Lamp.

STREET RAILWAY APPLIANCES.

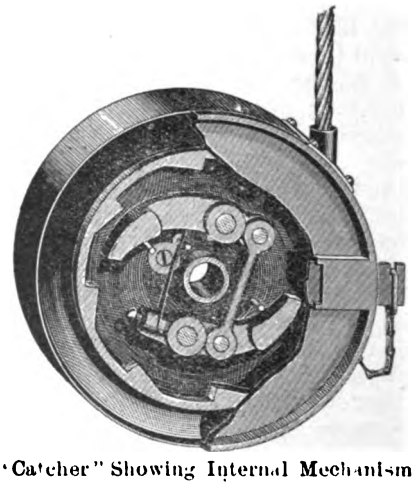
THE WILSON TROLLEY-POLE CATCHER.

When the trolley pole slips it is likely to damage the overhead wires. In order to obviate this difficulty, Wilson, Thomson & Company, of Brooklyn, N. Y., manufacture the Wilson trolley-pole catcher, by means of which the pole is instantly caught after the pole leaves the wire, and the damage it is likely to inflict is thus entirely prevented.

As shown in illustrations, it consists of a reel regulated by a long clock spring which takes up the slack rope. The internal mechanism shows that the sudden movement of the trolley pole makes the mechanism rotate, and centrifugal force causes the device to grip or catch. In fact, it is called a "catcher" and is attached to the car on the dasher. The catcher is supplied with number 7 or 8 "Sampson" trolley cord on reel and two



Wilson Patent Trolley Pole Catcher.



"Catcher" Showing Internal Mechanism.

dash attachments, with bolts for fastening. If the catcher is oiled once a week it will remain in good working order. The device may be so adjusted that the pole cannot rise six inches above the trolley wire after slipping.

The following directions are valuable: "To open, to repair or clean catcher withdraw cord, place catcher on its back, retard unwinding of reel spring by pressure of fingers on face of reel, unscrew set screw, turn catcher on its face, lift case, and case and reel will separate. To stiffen tension spring (if catcher catches too quickly), unscrew tin plate from post of tension dog, lift off dog and bend tension spring towards dog, sufficient to stiffen to requirement. Return parts as before, screw all screws tightly home."

Manufacturers of electrical goods seeking a market for their products will be interested in the following announcement:

The American Equipment Company, 203 Broadway, City, will, about December 1st, put one or more standard cars for electric railways in service on the principal roads in prominent cities of the United States, to practically demonstrate the most approved apparatus for electric railways.

Manufacturers of street railway goods having anything they would like to exhibit in this most practical manner to managers of electric roads should communicate at once with the above company, and they will arrange to exhibit the same at a nominal expense, compared with the benefit that the manufacturers will derive from such an exhibition.

The car will be accompanied by a person experienced in the introduction and exploitation of railway and electrical apparatus and supplies, who, being in touch with officials of the various roads, will have excellent facilities to further the exhibitors' interest. Manufacturers not already represented in New York can make arrangements whereby the American Equipment Company will represent them in New York and adjacent territory. Mr. O. S. Burr is the president of the company.

Luraville, Fla.—The Luraville & Suwanee River Telephone Company has been incorporated by Thomas I. I. McIntosh, of Luraville; Sidney V. Hough, Lancaster, Florida; L. T. Boatright, of Live Oak, Fla.; William T. Dees, of Mayo, Fla.; for the construction and operation of a telephone system. Capital stock, $3,000.

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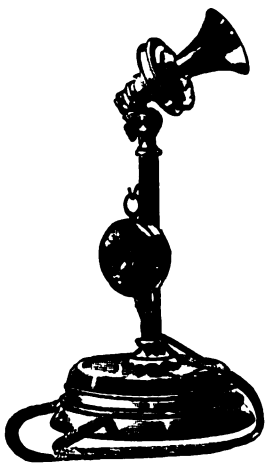
TELEPHONIC.

INTERIOR AND LONG-DISTANCE TELEPHONES.

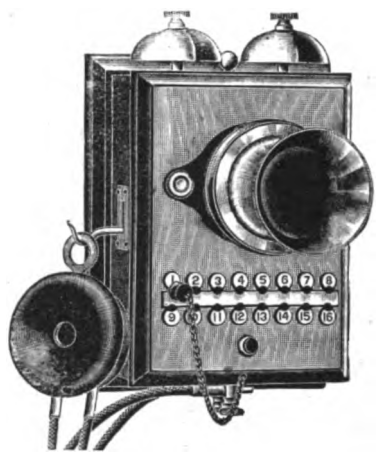
The telephone is an instrument which responds so admirably to the influence of the slightest vibration that, in spite of the millions in use, it is still regarded as a marvelous invention. A perfect telephone is one which transmits and receives the voice of an auditor with clearness and precision. Blurring of sounds should be entirely absent, and a pronounced audibility must be possessed by it in order to make its serviceability and convenience pronounced.

The Schmidt & Bruckner Electric Company, of 209 Greenwich street, New York City, manufacturers of interior and long-distance telephones, manufacture the "Twentieth Century" high-grade telephones, which, in clearness of sound, cannot be excelled. The Central R. R. of New Jersey say they are superior to the Bell, and state that with them they have been able to speak through a submarine cable to New York. Interference and induction of any kind are entirely absent, although with other 'phones speech was imperfect. The transmitters of the Schmidt & Bruckner Electric Company are built on the same principle as the "Ericsson," differing in the use of a solid gold plate in lieu of one that is merely plated. In the "Ericsson" transmitter the plating becomes worn, and the transmitter rapidly deteriorates.



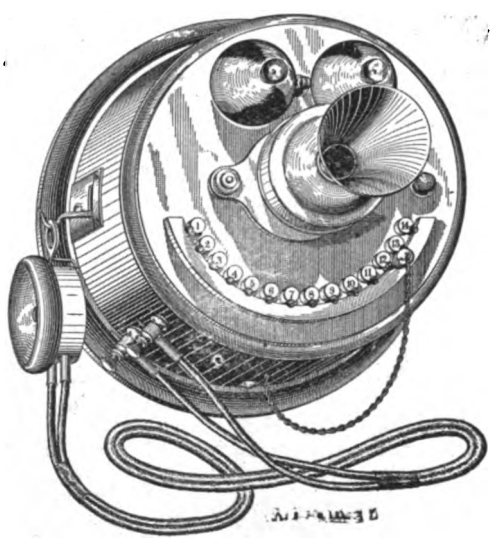
Desk Set with Double Pole Watch Case Receiver.

Battery Call Telephone.

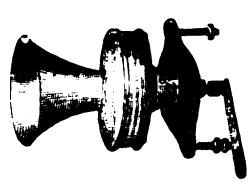


Smallest Intercommbnicating Wall Set.

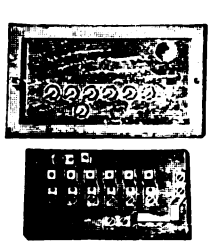
Magneto Call Telephone with Long Moveable Arm.



Smallest Intercommunicating Wall Set. Round Form.



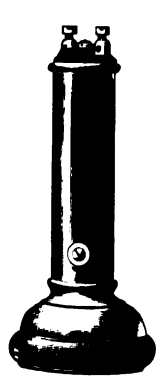
American Coal Grain Microphone.



Interior Intercommunicating Plug Switch.

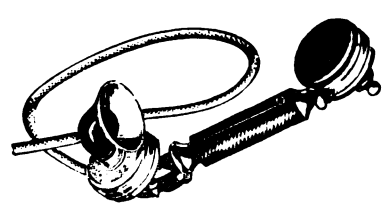
Intercommunicating Plug Switch.

Long Handle D. P. Metallic Case Receiver.



Standard Long Handle S. P. Receiver.

D. P. Watch Case Receiver.



Combination Micro-telephone.

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To testify to the superior quality of these instruments, we may state that the concern started business a year ago with only two men and are now employing over forty-five. Messrs. Schmidt & Bruckner are old Western Electric men; Mr. Schmidt occupying the position of foreman in the shops, and Mr. Bruckner that of inspector.

The interior intercommunicating system of this firm is one of the most complete, compact and practical outfits on the market. In making connection for calls on a numbered call, either on the face of the transmitter box or on the switch box, with the desk set no flexible cords are used, but this is effected by a plug on the one main line by connecting up a post on the desired call or number wanted. These connections take up very little room. They can put twenty-four calls or numbers on the face of a transmitter the size of a Blake box. The surface of the box is shown in the illustration, with transmitter and hook for receiver. They use imported granular carbon in all their transmitters, and as far as the receiver is concerned, its magnet is capable of lifting four and one-half pounds, being superior in this respect to the "Ericsson." The magnet of the receiver is double poled, the core of Swedish steel, making it of unexcelled quality. The transmitters are designed on the "Ericsson" plan. They can be removed from the case at any time, having no flexible cord connections.

Constant additions are being made to their line of specialties and improvements, which have and will make these telephones the best known on the market. One new feature has been the design of an entirely new arm for telephone sets used in office service, the features of which will be illustrated and described in a later issue. Their desk set is an innovation, in having done away with the flexible cord attachment, which is at present one of the greatest features of movable outfits.

Messrs. Schmidt & Bruckner's new desk telephones are built with a hard-wood base, the bottom of which contains all the connections and the coil. The base is grooved out all around one inch from the outside edge, which allows an iron cover to set in over it. This iron cover acts as a weight and protection to the connections. It is removable at any moment. The bottom of the 'phone is not covered with cloth or plush, but disks are placed all around the outer edge, leaving the cover free to remove. From the wood base a handsome post extends, in which is a spiral spring surrounding a contact rod. This rod has a hook, shown in the illustration, for holding the receiver. This hook works up and down with the rod surrounded by the spiral spring, forming a switch contact in the base. This avoids the use of small springs, etc., such as are generally employed. They use a double-pole watch-case receiver with their desk set of the "Ericsson" type.

The magneto used with all their long-distance and exchange instruments is provided with binding posts for receiver, battery and reduction coils. This important feature allows of the detachment from the backboard without cutting either the battery or transmitter wires. The magneto is made exceptionally fine, the steel used being of the very best kind. The armature is made of the best soft laminated iron, assembled on steel shafts, and is accurately fitted. A chain and sprocket wheel are used for driving, the special hard steel chain being guaranteed not to scratch nor to wear. The standard generator rings through 10,000 ohms. The switch hook is of the long lever type, well made, with all the contacts platinized, thus insuring good connections. The illustrations will give the reader an idea of the appearance and general construction of the "Twentieth Century" high-grade telephones.

Particular attention is called to the intercommunicating wall set, with battery return call for common return, and to the intercommunicating metallic plug system, dispensing with the flexible cord. The interchangeability of all their transmitters brings out quite an uncommon feature in their construction. The method of making contact with spiral-spring device, found in the desk set, is one of high merit. In fact, the newness in design and excellent finish of these telephones will recommend them at once to all purchasers. All instruments are sold under guarantee, the confidence of Messrs. Schmidt & Bruckner enabling them to stick to this guarantee on all occasions.

AN AMERICAN CIVIL ENGINEER IN KOREA.

Minister Allen sends the following, dated Seoul, July 16, 1898:

Korea has never had a proper survey made of its lands. The Treasury Department knows in a rough manner the extent of tilled fields as they existed a few hundred years ago, but new land brought under cultivation is apt to be known only to the country officials, who draw much of their considerable revenue from taxes on this new land. The people, of course, get no relief, for they will be most thoroughly taxed, whoever gets the money. Taxes are now paid in kind, and land is listed as rice land which is the best and most profitable, or upland, such as is used for barley, wheat, beans, etc. It has now been decided to have a complete survey made of the whole peninsula, preliminary to a just and proper assessment. An American, Mr. R. Krumm, of Columbus, Ohio, graduate of the Ohio University, has been engaged as chief engineer of the Korean Government "for the direction of all engineering work, such as the laying out of irrigation works, roads, bridges, fortifications, etc." Mr. Krumm has a five-years' contract with the Government at a compensation of $300 per month for the first year, and increasing $50 per month each year. He will also have house and certain expenses furnished. Mr. Krumm is now engaged with the engineering force of the Seoul-Chemulco Railway.

ELECTRICITY AS A FOG DISPELLER.*

The accident to La Bourgogne, due to fog, has brought out a lot of suggestions for warning vessels when in close proximity to one another. Probably the most original suggestion that has yet been advanced is that of dispelling a fog by means of electrical discharges. Mr. Alexander McAdie, in a recent contribution to the "North American Review," advocates some such method, and gives his reasons for so doing. At the outset he states that air at sea level at a temperature of eighty degrees Fahrenheit, half filled with moisture, has eleven gram of water vapor to each kilogram of air. If the temperature is lowered, say fifteen degrees, through a change in the pressure, the air will become saturated with water vapor, or in other words, will have all it can hold. Mr. McAdie then goes on to say: "If the mixed air and vapor can be lifted about 4,000 feet, the rain engineer can ordinarily form a cloud or fog. Conversely, if he can increase the pressure and supply the requisite amount of heat, he can alter conditions so that no fog forms, or if it has formed, cause it to disappear. Provided we can control the thermo-dynamic conditions, we can condense the invisible vapor of the air into visible cloud, and on the other hand change the visible fog into invisible vapor." In Mr. McAdie's opinion this desired result might be accomplished by a method suggested by Professor Oliver Lodge, the well-known English savant, some time ago, in a lecture before the British Association at Montreal. At that meeting Professor Lodge related some experiments which he had carried on with a view to discovering a method of dissipating dust fog, which frequently gathers in towns and cities. He stated that he had found that a bell jar filled with magnesium smoke

* Boston Transcript.

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or with steam could readily be cleared by an electrical discharge. Experiments were also carried on in a room filled with thick turpentine smoke, it being definitely shown that the air could be speedily cleansed of its solid particles by discharges of electricity at a high potential.

In 1887 Professor Lodge, while en route to this country, was detained for several hours by a very thick fog, regarding which he subsequently wrote as follows: "Fog is an unmitigated nuisance. Electric light is powerless to penetrate it, and as we lay there idle it was impossible not to be struck with the advisability of dissipating it. It is rash to predict what can be done. It is still rasher to predict what can not be done. I would merely point out that on board a steamer are donkey engines, and that these can drive a very powerful Holtz or Wimshurst machine, one pole of which may be led to points on the masts. When electricity is discharged into fog on a small scale the fog coagulates into globules and falls as rain. Perhaps it will on a large scale, too." Mr. McAdie thinks that the time has now come to try Professor Lodge's suggestion, made over ten years ago, and points out as one of his reasons that all steamships and even ferryboats, of any size are now equipped with dynamos which could readily be made to generate economically high potential currents of from forty to fifty thousand volts by the use of suitable transformers in series. He is of the opinion that "within a reasonable distance such discharges would certainly dissipate the fog and clarify the air." On the other hand, he admits that fog might be so dense as not to be affected by such electrical discharges, but thinks such cases would be exceptional. There would seem, in our opinion, no reason why such an experiment on a large scale should not be tried, as it could be done at comparatively little expense; whether it would prove successful, however, is debatable. That a discharge of high potential electric currents from a ship will dissipate heavy fog at any considerable distance from the vessel is scarcely to be expected, and unless the area cleared were of at least moderate size, thus allowing the lookout to see a considerable distance ahead and on either side, it would not render ocean travel materially safer than it is at present.

STREET-RAILWAY SPECIALS.

THE Sixth Avenue cars, operated by electric power, are giving great satisfaction to the Metropolitan Traction Company and the general public. This line extends from 59th street to 4th street. From 4th street the cars will run by way of West Broadway to South Ferry. About midnight last Friday the first trip was made. H. H. Vreeland, president of the Metropolitan Street Railway Company; W. Regan, of the Nassau Construction Company; W. Lang, superintendent of the National Construction Company; H. Belden, engineer of the latter company; General Manager Rounds, of the M. S. R'y Co.; Col. Harvey, of the Nassau Construction Company, and Walter Pierson, assistant to chief engineer F. S. Pierson, of the M. S. R'y Co., were aboard the first car. Walter Pierson, who formerly had charge of the lighting construction of the Brooklyn Heights Railroad Company, of Brooklyn, N. Y., ran the car as motorman. He took the handles of the controller and transmitted the current to the first electrically driven vehicle ever operated on that road. They started at an easy rate of speed, and the new road was tested and carefully inspected. Fourth street was reached at 12:30 A. M., and the car immediately returned. When business hours commenced the public took to the cars at once, and a rushing business commenced.

Mr. Sterges, the electrical foreman of the Flatbush Avenue line of the Brooklyn Heights Railroad Company, has been succeeded by the foreman of the Sumner Avenue line, who will assume his duties at Flatbush Depot. The career of Mr. Sterges as an electrician is excellent. In 1892 he was construction superintendent of the Consolidated Traction Company, of Albany, N. Y., and has held responsible positions in Boston, Philadelphia and Scranton. He was construction superintendent of a road erected in Trinidad, West Indies.

F. H. ROTH.

NEW YORK ITEMS.

MR. J. S. SPEER, the secretary of the Partridge Carbon Company, of Sandusky, O., spent a few days in New York, a short time ago, preparing the way for the introduction of their new "Perfection" carbon brush for motors. Mr. Speer is one of the most popular men among the electrical supply and manufacturing companies, his genial manner making him a favorite wherever he goes. Mr. James Partridge, the manager of the company, is a noted carbon expert and one of the most skilful manipulators of carbon in this country and Europe. The electric railway and other concerns using the "Partridge" brushes will appreciate the great improvements to be found in the "perfection" brush and the same will, without doubt, control the field as successfully as have the other brushes heretofore turned out by the above company. The Partridge Carbon Company also makes a specialty of carbon used for experimental purposes, all the great blocks of carbon used in experimenting with the manufacture of acetylene gas during the past few years having been manufactured by them. Their works are kept busy day and night in keeping up with the demand for their noted brushes, orders for 50,000 pieces for one road being considered nothing extraordinary.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 30 Cortlandt street, is preparing a new catalogue of its various lines of supplies and manufactures, and expects to have the same ready for distribution on or about October 10. Copies of this catalogue will be sent to all mentioning "The Electric Age."

WILBUR B. DRIVER & COMPANY, 126 Liberty street, sole agents for John A. Roebling's Sons Co.'s "CLIMAX" resistance wire, are now carrying a full stock of the same and are prepared to make prompt shipments from stock in all sizes from No. 5 to No. 36 B. & S. This wire has been growing steadily in favor since its introduction about a year ago and is now recognized as the standard wire for resistance work.

THE CHERRY ELECTRIC WORKS manufacture a perfect volt and ammeter at a surprisingly low figure. Circulars and price-lists will be sent on application, and they are well worth the time spent in looking them over.

THE NEW ERA METAL COMPANY, 26 Cortlandt street, manufacture a fine line of magneto and dynamo castings for the trade.

THE LE VALLEY VITÆ CARBON BRUSH is meeting with great success among users of the same on account of its self-lubricating, non-cutting and non-sparking qualities. The office of the company is at No. 39 Cortlandt street.

POSSIBLE INSTALLATIONS.

Florence, Ala.—The Florence Milling Company contemplates adding an electric-light plant to its mill.

Pratt City, Ala.—Pascal G. Shook and associates have received franchise for the establishment of a $9,000 electric-light plant in this city.

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Wynne, Ark.—William M. Kennedy, chairman board of improvement, may be addressed concerning bonds to be issued for the erection of an electric-light plant and the construction of a system of water-works.

Cassville, Mo.—Harrison Horine, mayor, may be addressed concerning erection of water-works and electric-light plant.

New Iberia, La.—A. J. Cammack, secretary, may be addressed concerning erection of an electric-light plant, construction of water-works in the near future.

New Orleans, La.—Cohn & Ber and T. M. Miller & Company have applied for franchises for the erection of electric-light plants.

Williamsport, Md.—Steps are being taken to erect an electric-light plant.

Oxford, N. C.—A movement is on foot to establish an electric-light plant in this city. Address Town Clerk.

Greensboro, N. C.—Steps are being taken to erect an electric-power plant for manufacturing and a more complete system of electric lights.

Orangeburg, S. C.—The mayor may be addressed concerning the erection of an electric-light plant and construction of water-works.

Chattanooga, Tenn.—The Heron Bedstead Company will erect a complete electric-light plant in its factory.

Houston, Texas.—Bonds to the amount of $120,000 will be issued for the purpose of rebuilding the electric-light plant recently destroyed by an explosion.

Florence, Ala.—The Florence Milling Company will put in an electric-light plant in its mill.

Sherman, Texas.—An electric-light plant is being established in this city.

TELEPHONE CALLS.

Trenton, N. J.—The Atlantic County Telephone Company has been incorporated in Atlantic County, N. J., by Frederick L. Benson, Alfred Dingler, Jersey City; John J. McCloskey, Philadelphia; to operate in Atlantic County. Capital stock, $100,000.

Ottumwa, Iowa.—The Ottumwa Long-Distance Telephone Company has been incorporated by J. C. Goddard, A. H. Cowdery and P. E. Wilcox, to build a long distance telephone line in the States of Iowa and Missouri. Capital stock, $10,000.

Meridian, Miss.—The Meridian Telephone Company has been incorporated by J. D. P. Lewis, J. P. Walker, Henry A. Coit, Henry A. Turner and others with a capital stock of $16,000.

Atlanta, Mo.—The Atlanta Telephone Company has been incorporated by H. H. Abbott, S. H. Nash, R. B. Turner and others. Capital stock, $2,700.

Bolivar, Mo.—Franchise has been granted to J. C. Pike and H. S. Bruce for the construction and operation of a telephone exchange.

Morgantown, W. Va.—The Morgantown & Dellslow Telephone Company has been incorporated with a capital stock of $100,000. Capital subscribed, $500; amount paid in, $50.

Ronceverte, W. Va.—The Greenbrier & Pocahontas Telephone Company has been incorporated with a capital stock of $1,500.

NEW INCORPORATIONS.

Des Moines, Iowa.—The Postal Telegraph Cable Company has been incorporated by C. F. Fox, R. J. Wurst, and R. W. Banks; for the construction, acquisition and operation of telegraph lines within the State. Capital, $50,000.

Detroit, Mich.—The American Electro Neurotone Company has been incorporated by Fred W. Christie, Niagara Falls, N. Y.; Daniel B. Stevens, Toronto, Ont.; Rollin H. and Clara B. Stearns, Pine Bluff, Ark.; R. L. Gibson, Toronto, and L. G. Christie, Toronto. Capital stock, $30,000.

STREET-RAILWAY NEWS.

New York, N. Y.—The Safety Third Rail Electric Company has been incorporated by Emerson McMillan, Jr., W. F. Douthirt, C. T. Schoville, R. H. Beach, William M. Keepers, David F. Halsted and others. Capital stock, $1,000,000.

BUSINESS CHANCES.

The American Electrical & Maintenance Company, No. 451 Greenwich street, went into the hands of receivers October 4, Justice Smyth, of the Supreme Court, having appointed Aldred K. Warren and Francis Higgins in proceedings brought by the directors for the voluntary dissolution of the corporation on the ground of insolvency. The liabilities are $35,199, nominal assets $29,126, actual assets $17,398, consisting of books, accounts, tools, patterns and materials in process of manufacture. The order to show cause for the dissolution was set down for January 16, before Hamilton Odell, referee.—N. Y. Journal.

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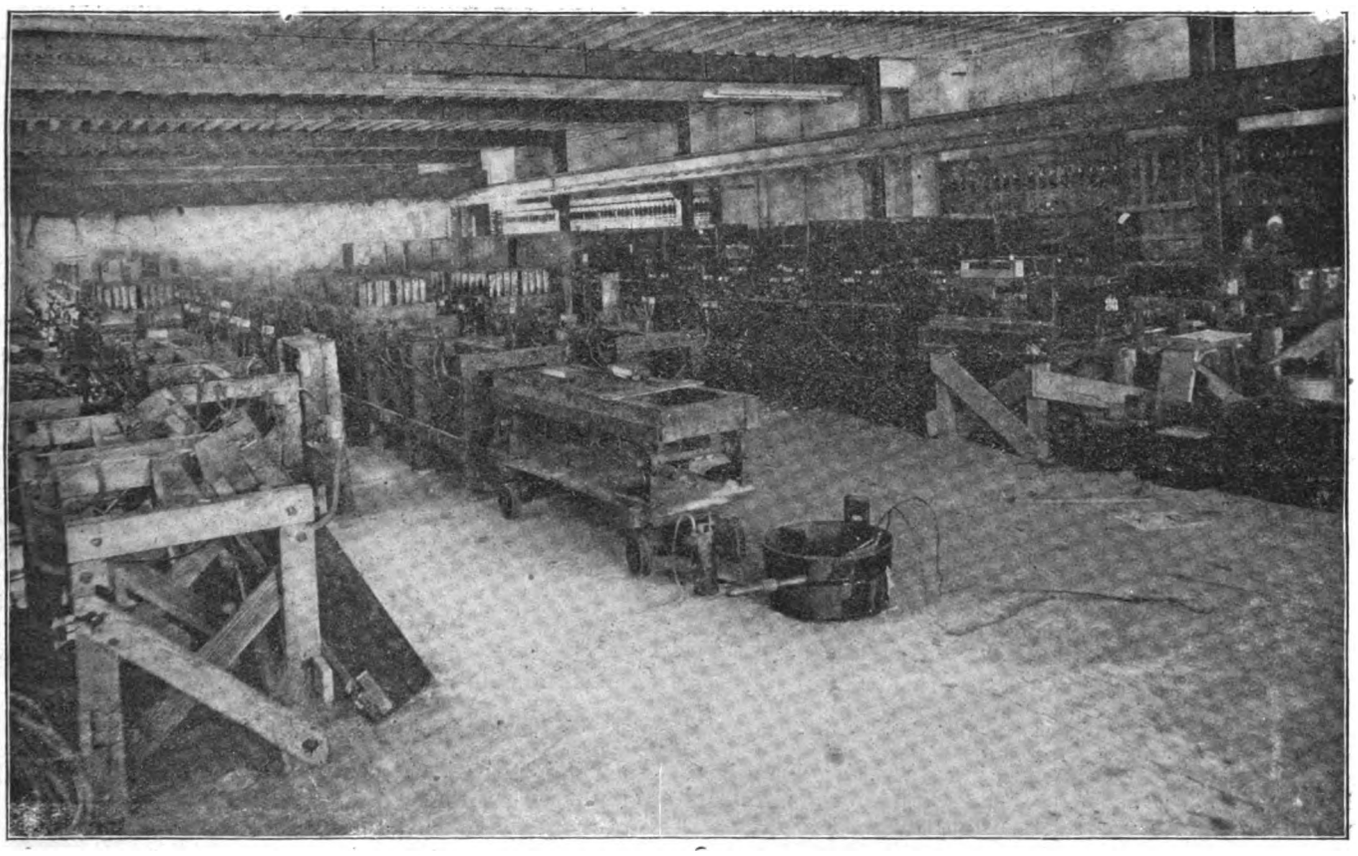
The Electrical Age.

VOL. XXII—No. 15 NEW YORK, OCTOBER 8, 1898 WHOLE No. 595

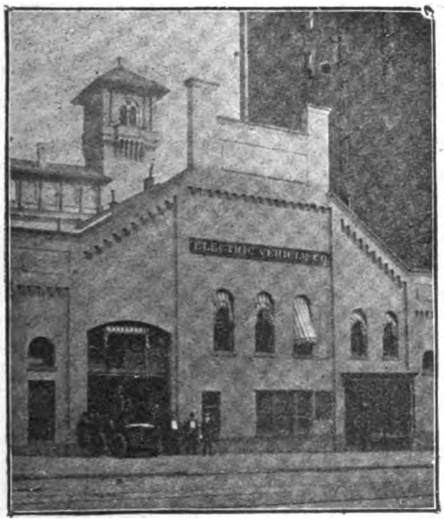
ELECTRIC AUTO-MOBILES.



Interior of Battery Room in Station.

CENTRAL STATION OF THE ELECTRIC VEHICLE COMPANY.

(Through the courtesy of the "Horseless Age.")



Exterior View of Station of Electric Vehicle Company.

The most complete plant in the world for the care and maintenance of electric vehicles is just being completed by the Electric Vehicle Company at No. 1684 Broadway, New York. The chief feature of this plant is the remarkable facilities for charging, loading and unloading the storage batteries from the cabs.

The old cabs, of which 12 were in service for over a year, have been displaced by cabs of new and improved design, though following the earlier model in the salient mechanical details. Fourteen of the new vehicles are now in service, and 20 or 30 more will be added soon. Of the 50 broughams ordered only one has been put in service, as the season for this class of vehicles is yet distant.

The building chosen for the station is an old rink fronting on Broadway and running through to Seventh avenue. Its dimensions are 75 × 200 feet, and as a storage place for cabs a floor has been raised over about half of the interior above the battery room, while in the front are business offices and in the rear drivers' rooms and a machine shop.

The battery room is 37 × 100 feet, and here several hundred batteries may be kept either charging or charged ready for use. At each end of the battery room are two elevators for raising and lowering cabs to the store room above.

In front of this room is the battery-loading machinery. Both the loading and unloading are accomplished almost entirely automatically. The carriage backs up against the charging table, its battery is removed and replaced, and the discharged cells are carried back into the battery room and deposited upon the proper racks and automatically connected with the charging circuits. If the vehicle requires attention or is not to be used for a time it simply recharges its battery and is hauled to the space alongside of the battery room, where it is washed and cleaned and sent back to its resting place on the upper floor by the rear elevator till again wanted. If it is simply recharging, it, of course, receives a new battery. The time required for this operation is about three minutes.

The weight of the new cab, including the battery, is about 2,900 pounds. Its length from end to end is nine feet; at its widest portion the body measures five feet;

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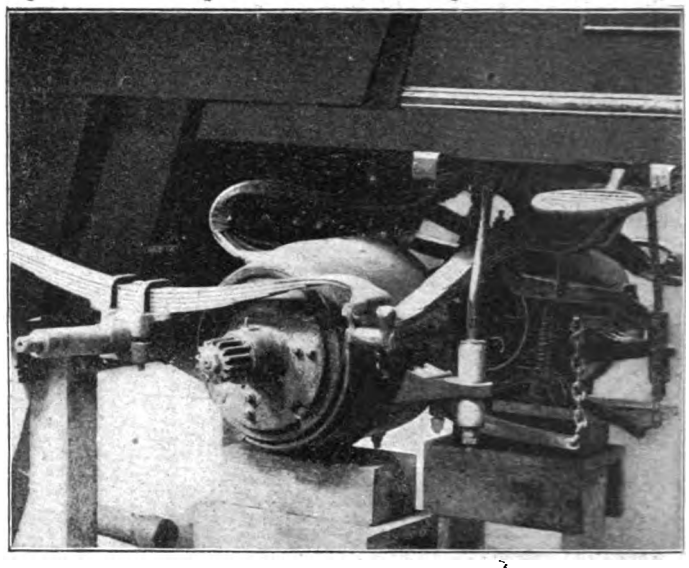
the wheel base is 4 feet 7¼ inches, and the gauge of of both front and rear wheels is 4 feet 10 inches. In regard to the arrangement of the driving and steering gear the same disposition has been adopted, the wheels being used for driving and the wheels under the battery box for steering.

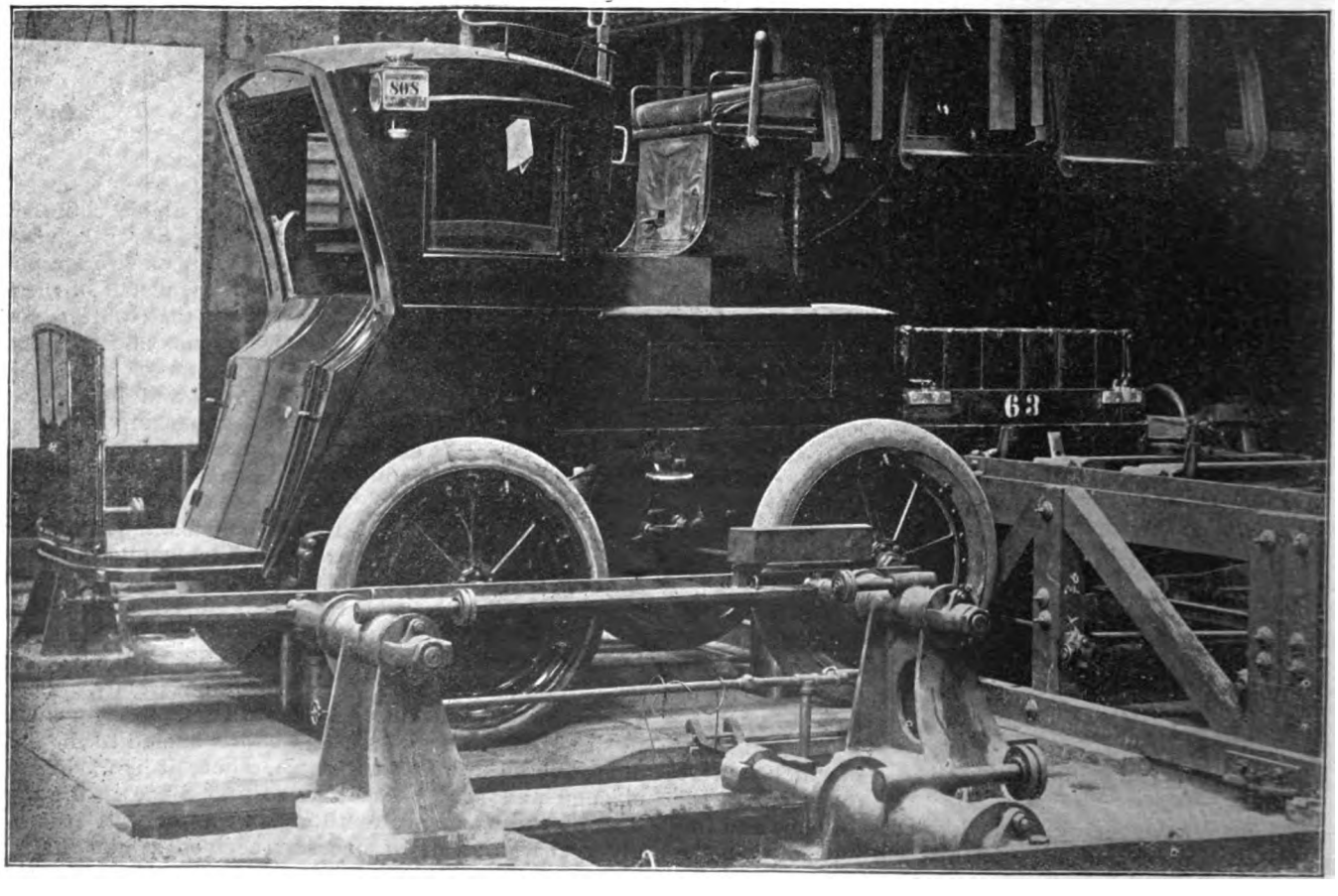
One of the most striking changes is the massive pneumatic tires. Experience demonstrated the failure of the 3-inch pneumatic tire with which the old cabs were equipped, and a 5-inch tire was adopted. They are made of ½-inch rubber hose stock. Larger wheels would have been used had it been possible to obtain the necessary tires. The present 5-inch tires are pumped to the pressure of 60 pounds. The vehicle wheels are built of two stamped plates of ⅛-inch steel. They are fastened at their periphery to the convex edges of the metal rim and expand to the hub, to which they are bolted. The diameter of the wheels is 36 inches, and the weight approximately 100 pounds each. Several of the cabs have been equipped with a wooden-spoked wheel with better results.

All four wheels have roller bearings, with double ball thrusts. The width of the running bearing surface is about 5 9-16 inches. The driving wheels revolve about a fixed axle measuring 1½ inches at the bearing ends and centrally fastened at either end to a flat compound spring, upon which the forward end of the vehicle body is supported. Each wheel is driven by an independent motor, and there is no connecting gearing between them.

Electric Vehicle Company's New Car.



Motor Suspension and Brake Mechanism.



Electric Hansom, Showing Hydraulic Ram for Side Alignment and Battery in Position for Loading.

The series-wound motors are of a new water-proof iron-clad construction, and resemble the general type of street

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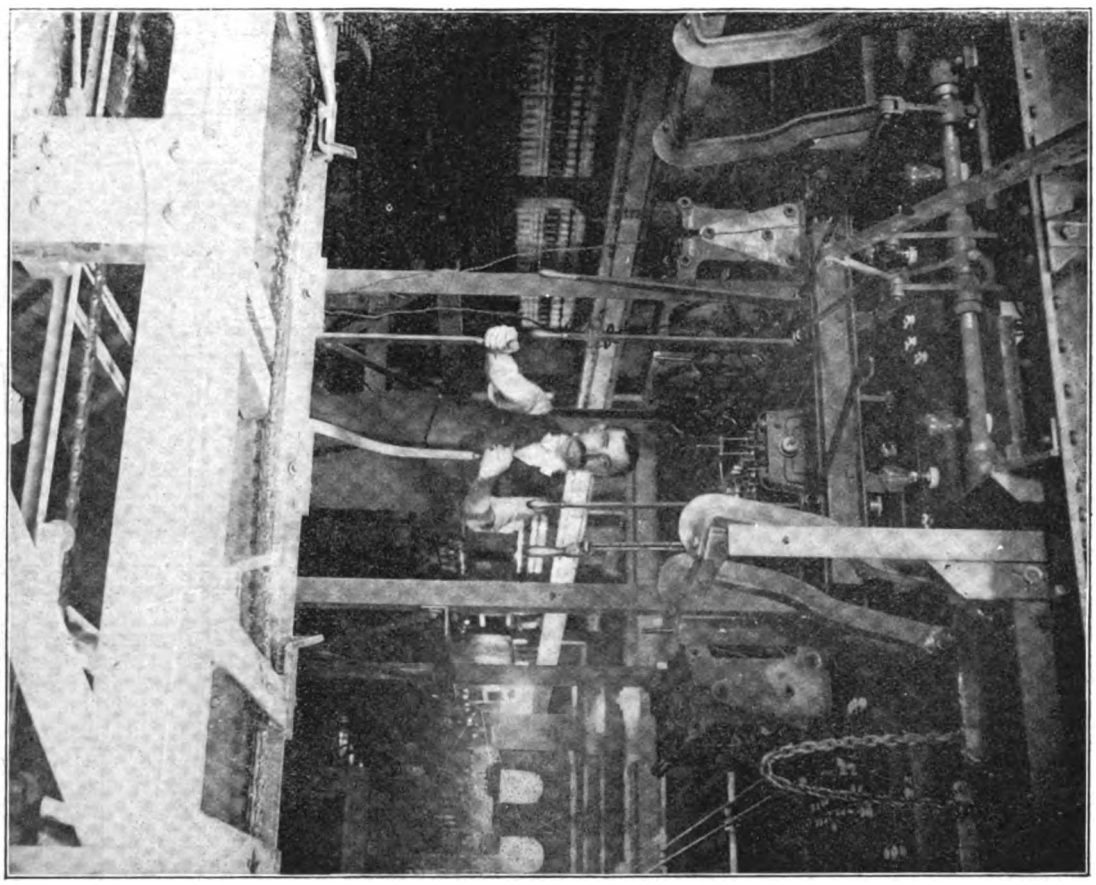
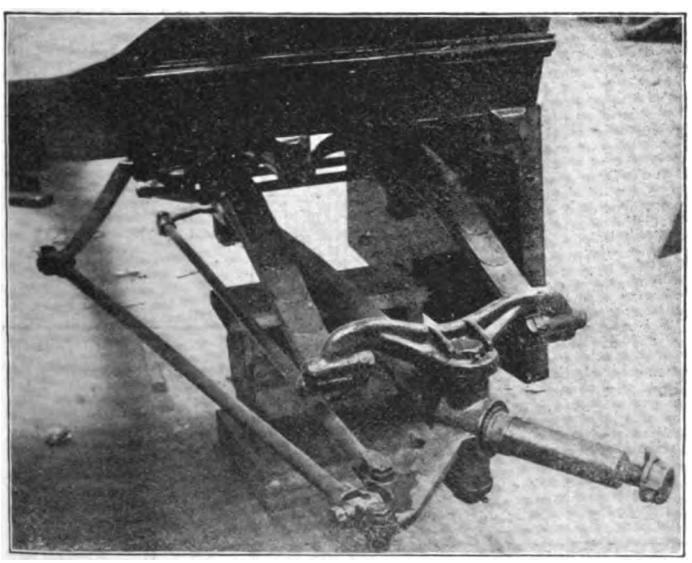
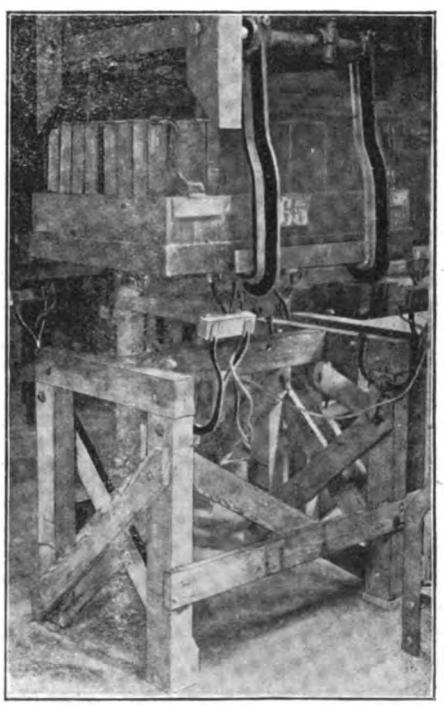
railway motor. They were built by the Westinghouse Electric & Manufacturing Co., and have a capacity of 2 H. P. at 700 r. p. m., when working at 80 volts, the potential of the battery in each vehicle. With the exception of a small hinged door at the commutator end of the outer casing, the motors are practically sealed. In supporting these motors and gearing them to the drivers, electric railway practice has been followed. Each motor is pivoted by a projection to the fixed axle, adjacent to its respective driver. A small spur gear pinion meshes into an internal gear, 21 inches in diameter, attached to the inside of each driving wheel. Thus fitted to the wheel the gears almost directly transmit their strain to the rim, instead of passing it through the web or hub. At the opposite side of the motor a projecting arm is held between two rubber springs. This motor gearing possesses all the elements of the flexible pivotal suspension.



View of Crane Cab and Operator.



Steering Gear.



Charging Table and Grappling Devices.

The steering gear is of the pivoted type.

It will be noted from the illustrations that each set of wheels is independent. The driving and steering wheels are separately attached to the vehicle body, through the medium of the spring supports.

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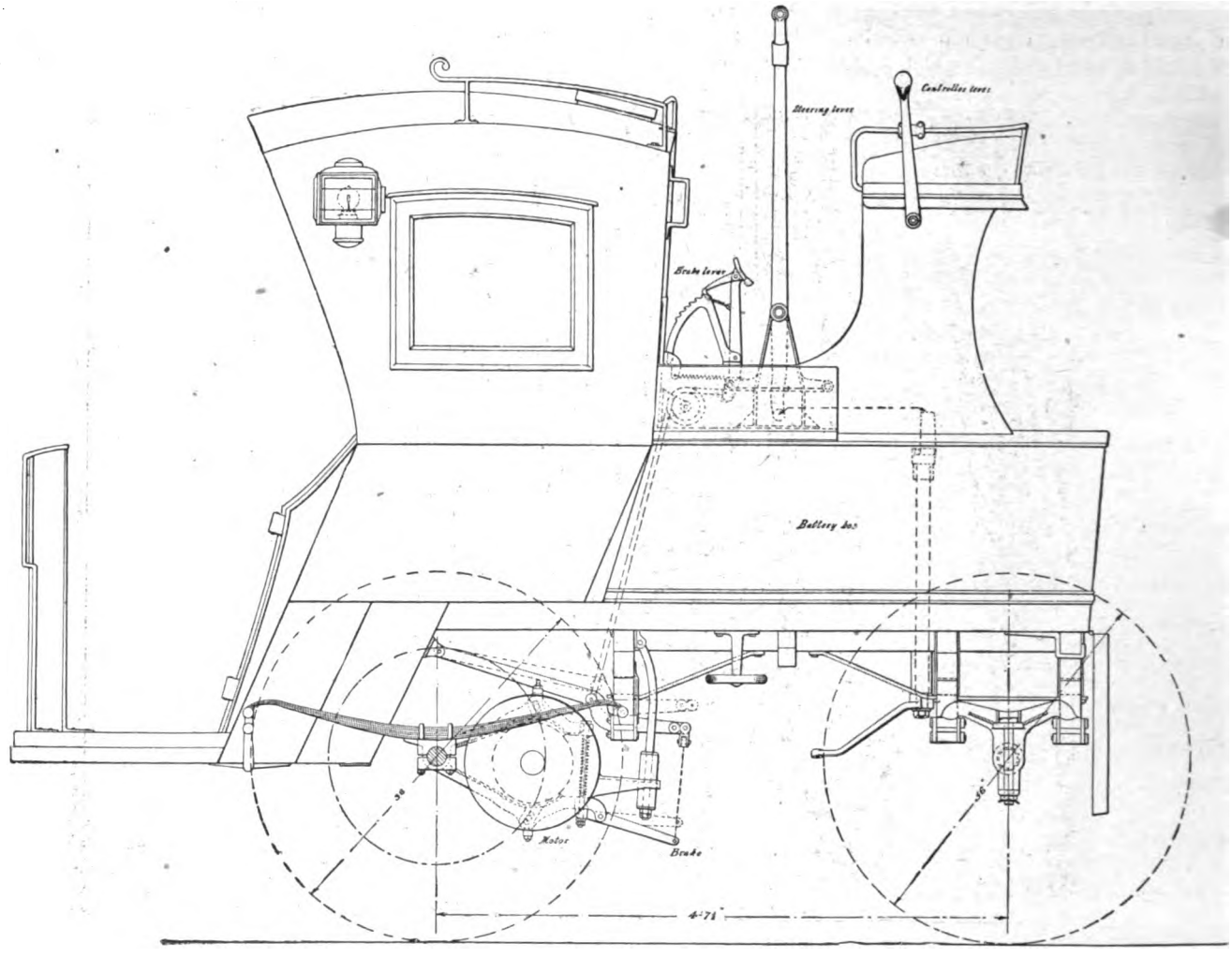
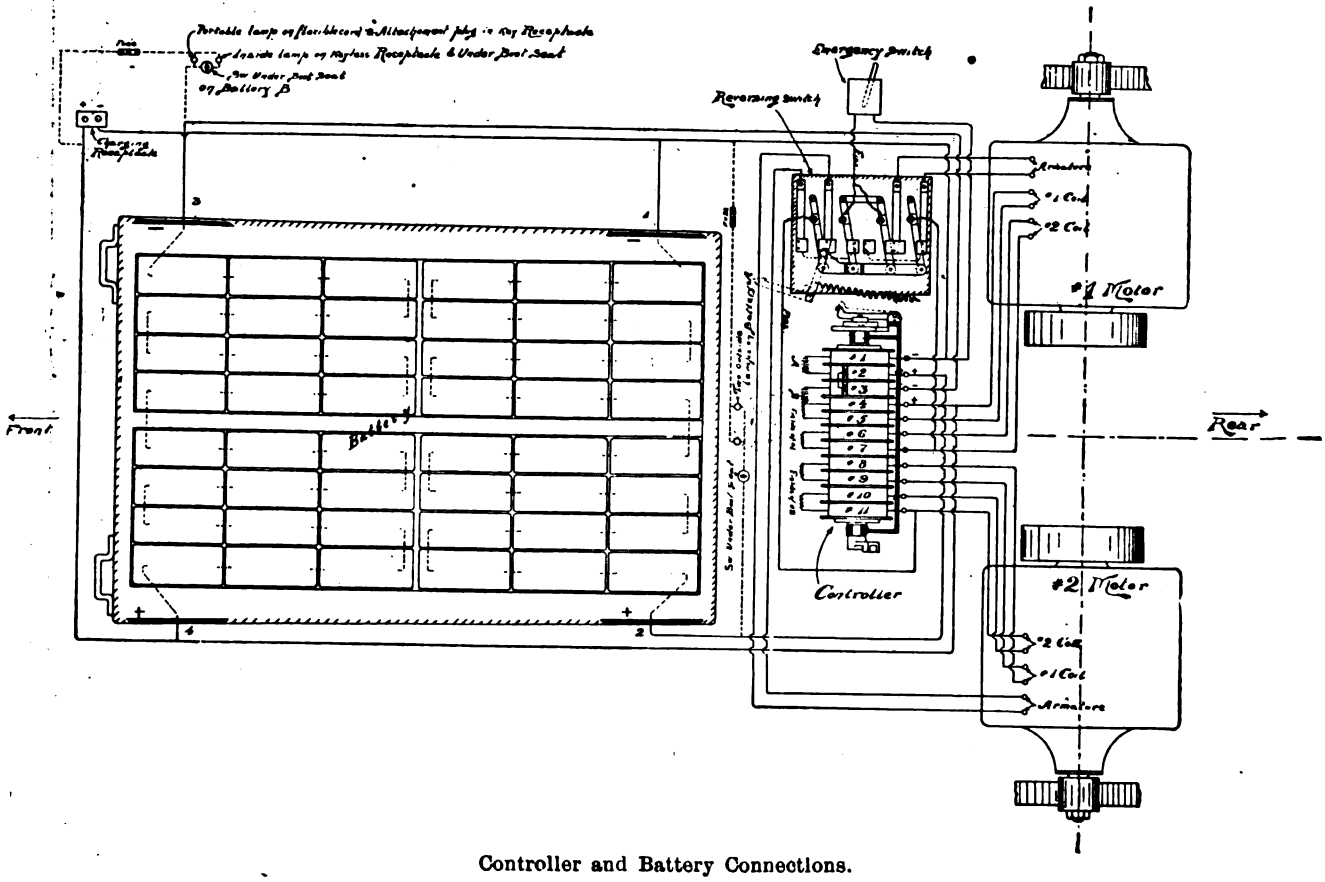
Each cab is equipped with 48 cells of battery, which contain two Manchester positive and three chloride negative poles. The battery has a rated output of 100 ampere hours at the normal discharge rate, but the irregular



Side Elevation of Electric Cab.



Controller and Battery Connections.

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THE INCREASING USE OF ALUMINUM FOR ELECTRICAL CONDUCTORS.

Aluminum, or, as it is technically called, aluminium, is a metal whose future history in applied electrical engineering is slowly becoming one of great consequence. The electrical conductivity of aluminum is so great comparatively that there is every reason to suppose a change of sentiment regarding its use. It possesses qualities of strength, lightness and conductivity which should insure its receiving a favorable reception at the hands of broad-minded experts. Mr. Alfred E. Hunt, whose name in connection with the aluminum industry is well known, claims a conductivity for aluminum of more than one-half of that of copper. Bulk for bulk, aluminum weighs less than one-third that of copper.

It is evident from these facts that an aluminum conductor capable of carrying a given current would have about twice the cross-section of a copper conductor and about two-thirds the weight, or less. The cost of a power transmission line involves not only the expense for copper, pure and simple, but the expense as well for its erection. The heavier the conductor the stronger must be its supports and the more massive the insulators attached to it. Gisbert Kapp's modification of Sir William Thomson's law, as well as Prof. George Forbes' opinion in relation to conductors used for transmission of power, might be applied in this case, particularly the latter. It seems as though the cost of laying each additional ton of copper has largely to do with the cross-section of the conductor. Can the cost of laying an additional ton of copper or any other metal be reduced? In other words, does the use of aluminum as an electrical conductor mean a saving in dollars and cents?

Mr. Hunt states as follows: "To obtain a conductor of aluminum at the same cost of metal per mile, the cost per pound of the aluminum may be two and one-tenth times greater than that of copper. Assuming the cost of the copper at fourteen cents per pound, it is evident that aluminum at twenty-nine cents per pound is slightly cheaper than copper. The strength of an aluminum wire can be made as great as that of a copper wire, more than thirty thousand pounds per square inch; the aluminum wire, however, possessing a greater cross-section than the copper wire, in order to have an equal conductivity, will be a stronger wire. Consequently, we find the following features in favor of aluminum: The cost less than copper, the strength greater than copper, and the weight less than copper. Several large power transmission plants are now using aluminum conductors. It is very likely that its use for this purpose will soon become better known and the demand more general.

ELECTRICITY IN MODERN SURGERY.

The use of electricity in modern surgery has kept in line sufficiently to stamp its progress as indicative on the part of the medical fraternity of a full appreciation of benefits derived from its use. The field of electro-cautery is too well known to dilate upon, yet the modern surgeon, the up-to-date specialist, finds electricity a most beneficial agent in his general practice. The dental world has become thoroughly familiar with the principles of cataphoresis, which implies the transmission of a medicament from one point to which it is applied externally to another. The use of electric saws for surgical work, such as amputation, etc., has been of great service to the profession, and in electro-therapeutic work the use of currents as tonics, stimulants and invigorators of the nervous system has become a fixed part of medical practice.

Dr. C. R. Dickson, president of the American Electro-Therapeutic Association, at the recent meeting of the organization in Buffalo, made the following remarks: "The old-time practitioner, then the physician and surgeon, seems passing away. Surgery is divided and subdivided until at one time we feared that we were to be confronted with an appendix surgeon. The time is past when a physician, the proud possessor of a solitary magneto-electrical machine, turned by a crank, considered his "armamentorium electricum" quite complete. One has but to glance at our programmes to see to what extent electricity may be used and used to advantage. . . . Electricity is an agent most powerful for weal or woe. A great responsibility rests upon our educators, and the sooner they awake from their strange lethargy the better will it be for our reputation as an enlightened, progressive and scientific profession. The commercial world has taken such advantage of the rapid strides of electricity as a science with fixed laws that we have laid ourselves open to the charge of neglect."

Perhaps Dr. Dickson does not fully realize that the cautery needle and X rays have practically transformed certain departments of surgery. His idea that the medical world is not progressing rapidly is a mistaken one. It has used electricity on every occasion dictated by judgment and experience. Large concerns manufacture apparatus of an electrical character exclusively for physicians. Electricity in modern surgery has left the field of charlatanism. The expression is not ambiguous. As a remedial agent it is applied by some of the best physicians in this country. There are certain misapplications of it made, but these are striking exceptions, and on the whole criticisms of its use have been, abroad as well as in the United States, of a most favorable nature.

Chicago, Ill.—Eureka Electric Co. has been incorporated, with a capital stock of $10,000.

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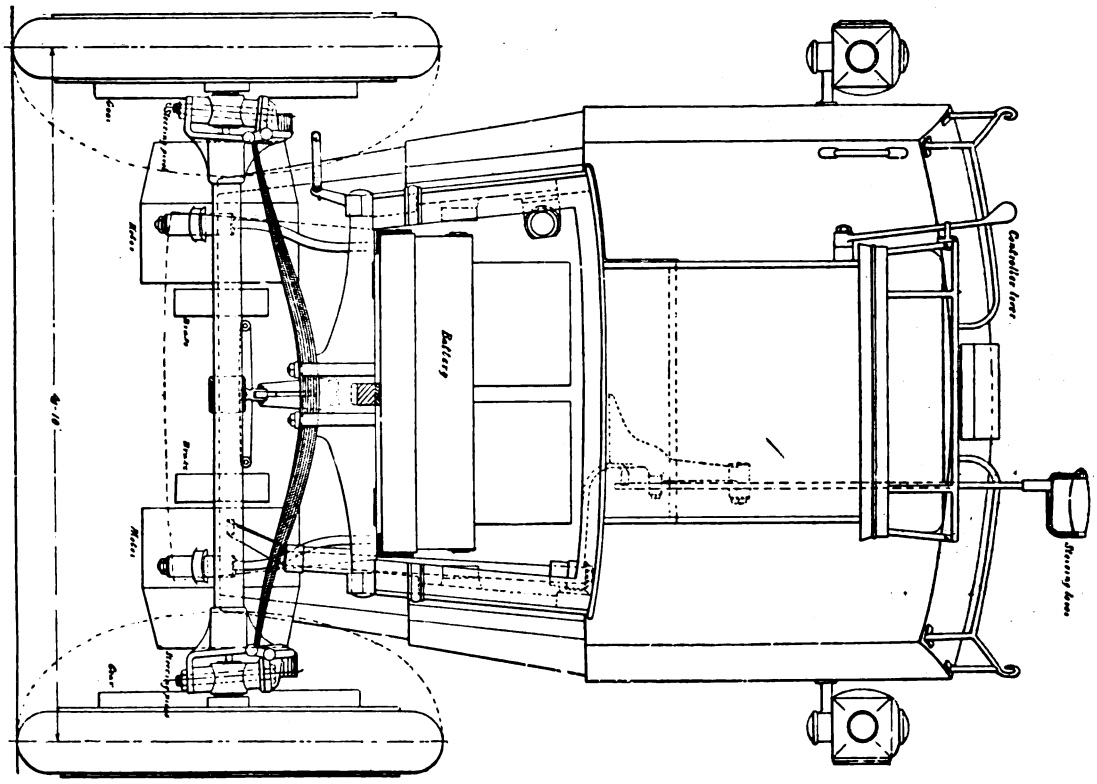
demands of this service change the rating. Each cell weighs 26 pounds, making the total weight of the battery carired by each vehicle 1248 pounds, exclusive of the holding tray.

The entire battery equipment for each vehicle is in a single box, thus making it possible to handle it as a unit. The tray, which is of wood, is slightly tapered, so as to fit the vehicle box snugly and insure good contact. The battery in its tray measures 26 inches in width by 3 feet 3 inches in length and 16 inches in height. The connections between the cells are burned together and those between the battery and controller system are automatically made, when the former is placed in position. The automatic contacts engage with four contact strips on the side of the battery box. The bottom of the battery box is lead lined and provided with suitable drainage channels.



Rear View, showing Details of Construction.

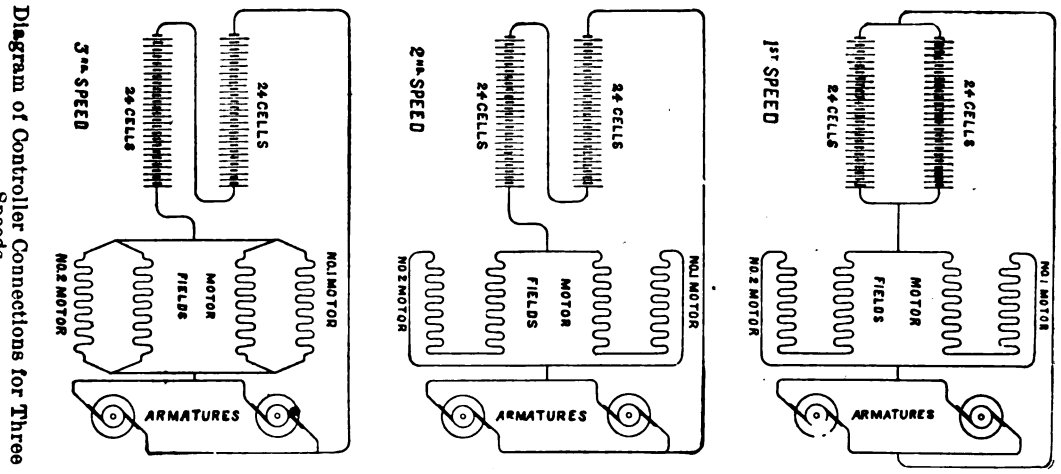


Diagram of Controller Connections for Three Speeds.

The operation of the vehicle requires three appliances, all located at the side or in front of the driver's seat. The speed of the motors is controlled by a switch cylinder, placed transversely under the driver's seat and operated by a rotary motion imparted by an upwardly projecting handle. This cylinder is used in combination with the reversing switch, which is provided with levers operated by the driver's foot. The arrangement is interlocking, and therefore it is impossible to reverse unless the controller is at "off." The reversing switch is normally set for the ahead position and so remains, unless pressure is kept upon the operating lever. Three speeds in either direction are provided, namely, 6, 9, and 12 to 15 miles an hour. The various combinations of the battery and motors are shown in the controller diagram. The battery is divided into two electrical sections, and the series fields are also in sections. Various series and parallel arrangements of the field coils and battery produce the three speeds. With a single charge the vehicle can be operated about 25 miles.

An emergency switch is provided, which has a removable key handle and is placed in an easily accessible position near the driver's foot, so that when occasion demands he can move the handle and thus cut off all current. This switch is also used when the driver leaves the vehicle. By removing the handle the switch is opened and cannot be closed until the handle is replaced, thus preventing any tampering by unauthorized persons.

The brake is operated by means of a foot lever and acts upon the armature shaft. It is of the double-acting shoe type and is applied to the brake pulley. The brake shoes are in the form of curved levers, one end of which pivots on the axle.

The operator has one foot always on the brake lever and

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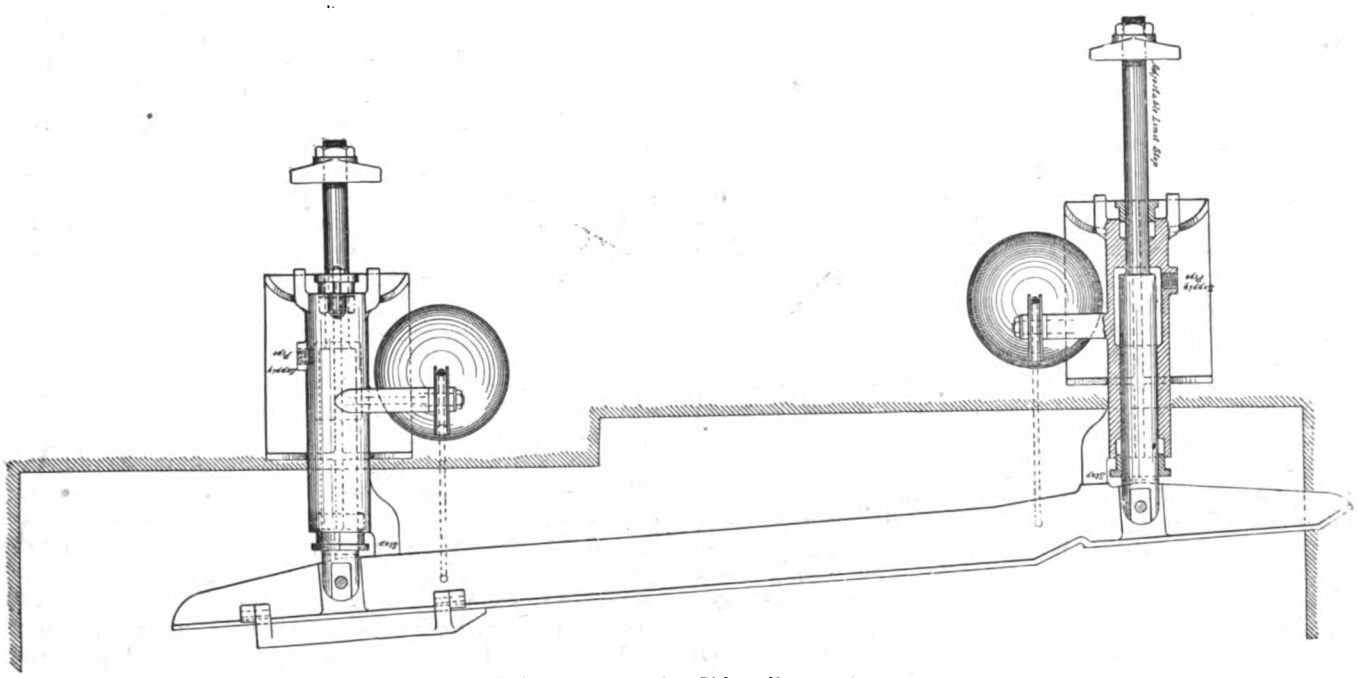
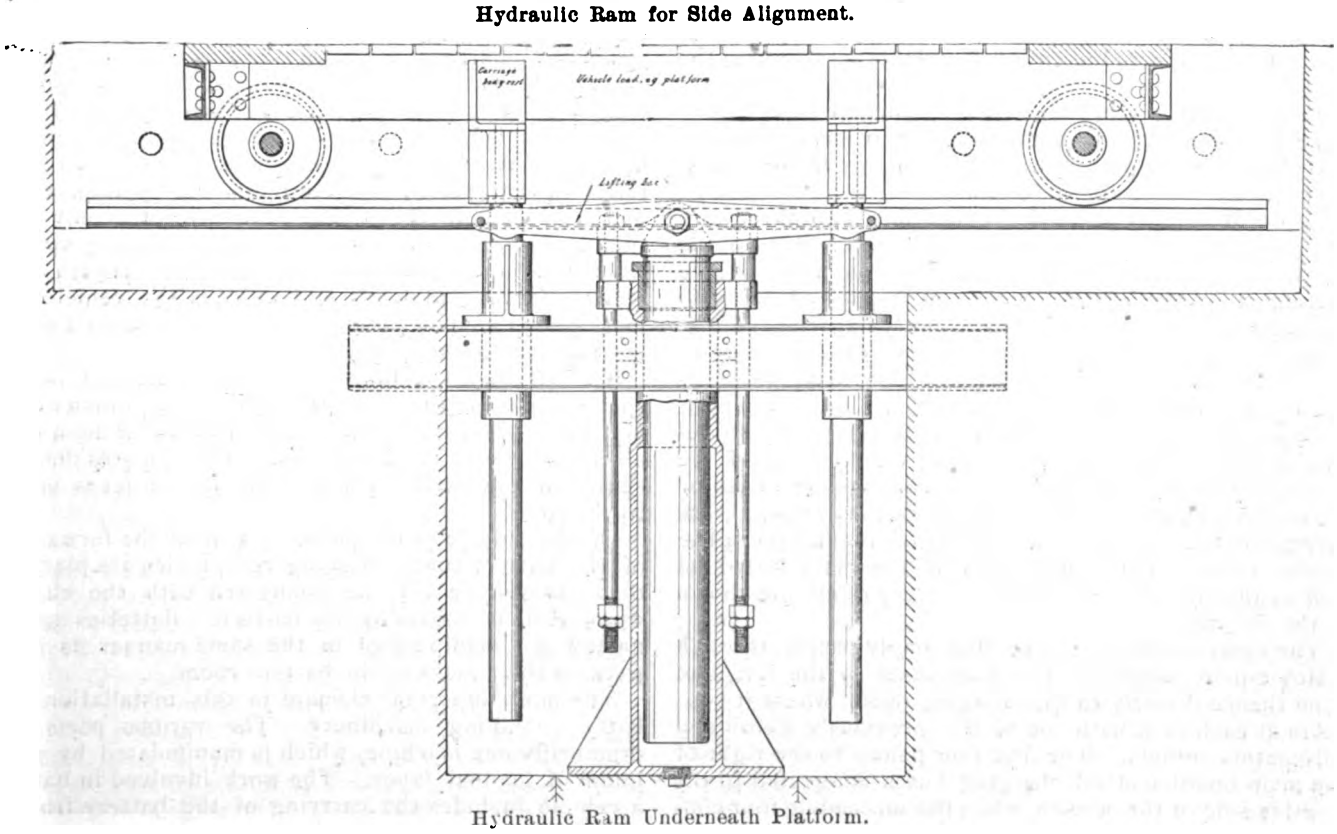
the other ready to operate either the reversing or emergency switch or the bell-ringing lever. His hands are occupied with the steering lever and the controlling handle.

An important feature in the construction of the vehicle is the duplicate character of the various parts, including controller, motors, switches and other parts likely to fail. The speed controller contact fingers are duplexed, so that each terminal from the battery or motor is connected to two stationary contact fingers. Each complete set is arranged in a separate row, engaging with the contacts on the cylinder. The contact plates on the battery tray are also in duplicate. The battery may be charged without removing it from the vehicle by connecting with the charging plug receptacle, fitted in one of the corners of the battery compartment. This receptacle is conveniently arranged and coacts with a suitable plug attached to the charging mains. It is expected to add vehicles of larger capacity in the near future, and several of the omnibus type are being considered.

The battery equipment for the present service consists of 150 trays, each containing 48 cells. This allows 1½ trays per cab, which leaves ample reserve, even though nearly all the cabs should be in service. The disposition of the batteries when not in actual service on the vehicles or when charging is excellent.



Hydraulic Ram for Side Alignment.



Hydraulic Ram Underneath Platform.

Owing to the large floor space available, all of the battery holding racks have been placed on one level. The battery room is floored with cement, as is also the entire ground space outside. Each tray of battery cells has a separate rack, built of 3x4-inch yellow pine, mortised at the joints, held together by wooden dowels, and coated with water-proof paint. The height from the floor to the top on which the battery tray is placed is 33 inches.

The arrangement of racks is shown in the general floor plan of the station. They range longitudinally

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from end to end of the battery room, with a narrow passage between each row. The central passage is wider than the others to accommodate the crane cab. There are also three wider passageways transversely across the battery room, in addition to those at the ends. Thus, the eight rows are cut into four parts, each containing six racks, which are tied together by wooden planks and rigidly fastened to the floor. This divides them into eight sections, each accommodating 48 trays, with the exception of the end section nearest the loading machinery, which has eight additional racks, making an aggregate of 200. These sections are provided with suitable drainage channels, and a large wire channel runs transversely from the charging switchboard on the inner wall of the building along each of the passageways. The lowering of the battery into the rack automatically connects it with the charging wire. At each corner of the rack is a curved lever, pivoted on the side of the upper timbers. The upwardly projecting ends are fitted with insulated spring contact straps, and when the lever is moved these describe an arc, thus bringing them in contact with the connecting plates on the ends of the battery tray. The weight of this end of the curved lever causes it to swing free when the cells are raised. The other end of the lever is quite short and projects an inch or two above the top of the tray supporting timbers. When the battery is lowered its weight strikes upon these projecting ends, causing the other ends to spring up and make secure contact with the plates on each side of the tray. As the cells in each tray are divided into two sections, it is necessary to provide each rack with four of these automatic contacts. The charging wires are connected to two diagonally opposite contacts, and the other two are cross-connected by a flexible rubber-insulated cable. This connects the entire 48 cells in series across the line.

Instead of furnishing the charging current from an isolated generation plant in the building, it has been found preferable for the present to take the supply from the Edison service.

At the Broadway end of the building two three-wire 350,000 c. m. service connections are brought into the north wall, whence they connect through three-pole switches to cables of 1,500,000 c. m. capacity leading to the main switchboard, which is located between the battery room and the offices. This main board is made up of nine white marble panels, each 3 feet long, making the entire length of the board aggregate 27 feet, with a height, including the supports, of 8 feet. At this board the three-wire street service connects, through the medium of the appliances on the panels, to a series of buses of raised or lowered potentials. These buses, of various voltages, are carried to the battery charging panel further on in the battery room. The connections of the main board, as well as the charging board in the battery room, are shown in the diagram.

The neutral wire of the service simply passes through a single-pole switch on the first panel to the left, and from thence directly to the charging racks, where it connects at each rack with one of the previously mentioned automatic contacts. The first four panels to the right of the main board control charging buses connected to the positive side of the service, while the succeeding four control negatively connected buses. The battery racks are connected to both the positive and negative charging buses through the switches on the charging board. The buses are thus connected at their respective panels through a single pole switch, and under-load or over-load I. T. E. circuit breaker and a large rheostat, whereby the potential may be lowered to any desired extent. This arrangement is the same with all of the charging panels, except the first and fifth, which are arranged to boost the potential of the connecting charging buses, or keep them at the same point as the street service. In this case the rheostat is omitted, and a double-throw pole switch is installed, which throws the buses in series with a boosting dynamo, or simply connects directly to the service buses. The capacity of the instruments on each of the charging panels and their respective buses ranges in steps of 100, from 100 amperes for the high-pressure panel to 400 for the low. The last panel on the right is to be used for light and power switches and instruments.

The booster equipment consists of a 7½-H. P., 220-volt multipolar dynamo, centrally placed between two bipolar booster dynamos. The armatures are directly coupled together. One booster raises the potential on the positive bus, and the other is used on the negative side, and the capacity of each measures 200 amperes, at from 5 to 15 volts. These machines are placed on a heavy wooden platform above the switchboard.

The object of the various charging buses will be apparent on examination of the charging panels. These are arranged in two groups in the battery room. They are built of heavy slate slabs, measuring 30 inches x 60 inches. Each panel is equipped with the instruments for eight charging circuits leading to the racks. A separate wire from each battery rack extends in a lead-armored cable, laid in the previously mentioned trenches, to its respective panel section. Each battery wire connects through a form of solenoid ammeter to a four-point switch arm, whereby it can be connected to any one of four charging buses. The upper row of ammeters and switches is connected to the positive buses and the lower row to the negative. In charging, a battery is connected, first with the lowest bus through the four-point switch and gradually worked up until the highest bus is reached.

To govern the changing from one bus to another, according to the current fed to the battery, the ammeters are provided with a tell-tale lamp indicator, which is set at charging current, 20 amperes low and 50 amperes high. Should the current fed to any battery reach these extremes a red or green incandescent lamp is lighted. Only one set of lamps is provided for each panel, and the lighting of the low-range lamp shows that one of the batteries on that panel has fallen below the 20-ampere point and must be connected to the next bus. The only attention necessary is the shifting of the charging switches from time to time, and this is done by the man who operates the crane and loads and unloads the vehicles. In fact, he can control the entire equipment, almost without leaving his station on the crane cab.

To withdraw the fumes from the somewhat inclosed space which comprises the battery room, a 40-inch exhaust fan is placed on the upper floor and operated by a belted electric motor. The fan suction flue originates about the centre of the partition wall, while the outlet is brought to the roof.

On the outside of the partition wall at the forward end of the battery room charging receptacles are placed, so that any vehicle may be connected with the charging wires without unloading its battery. Batteries so connected are manipulated in the same manner as if they were on their racks in the battery room.

The most important element in this installation is the battery-handling machinery. The various parts form practically one machine, which is manipulated by a minimum of manual labor. The work involved in handling a vehicle includes the carrying of the battery from the rack to the loading point, and here, after proper alignment, pushing the battery into its compartment. In unloading, these operations are reversed. The battery is moved from the rack to the loading point by means of an electric crane, carrying eight electric-battery hoists. This crane has a capacity of eight tons and runs the entire length of the battery room, which it spans from side to side. On each side of the operating cab, which is centrally suspended from the bridge and almost touches the floor, are the battery hoists. These are placed side by side, four on each side of the cab, and come directly

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over each row of battery racks. Each hoist has a capacity of one ton and works in conjunction with a lifting and lowering grapple, which automatically engages with the battery tray. The grappling arrangement consists of two heavy iron jaws raised or lowered by two chains, one of which performs the hoisting and the other manipulates the grappling arms. The drums for each of these hoists are operated by a separate worm-geared motor. In raising a battery from the racks the grapple is lowered in its open condition until it reaches the limit of the chain, which is set so that the arms are then just below the bottom of the tray. The further rotation of the hoisting drum winds the chain up again, closes the grappling arms around the bottom of the tray and raises it to the desired height. The operator in the cab simply starts and stops the motor, which starts in one direction only and does the rest. The battery is now carried to the loading transfer table, which is also electrically operated. This mechanism is really a link belt conveying machine, and extends across the entire front or loading end of the battery room. It consists of heavy iron crossbars with upward projections, forming the sections into which the tray fits. The battery is lowered and deposited in one of these carrying sections of the conveyor. The lowering and releasing is the reverse operation of the raising and is accomplished by an opposite rotation of the hoisting drum. The transfer of the battery tray from the conveyor or table to the vehicle compartment is accomplished by hydraulic machinery. In front of the table are two vehicle loading and unloading platforms. Each of these platforms is composed of two wooden flat carlike structures placed side by side, so that their platform is on a level with the flooring of the station. The wheels upon which these platforms are placed run on parallel tracks in the platform pits, the motion being in line with the conveyor table. Each half of the loading platform has four wheels and the two parts are automatically aligned with each other and centred by means of suitable weights. The vehicle backs on to the platform, so that each pair of wheels has a movable car to itself; and the vehicle can then be shifted from side to side and suitably aligned with the conveyor rack. Another alignment is necessary to level the bottom of the battery compartment, due to the change in the level of the vehicle battery box, when loaded or empty. In fact, this part of the vehicle sinks several inches by reason of the compression of the springs and pneumatic tires.

The vehicle is run into this position with the rear door open, and when thus aligned and leveled is ready to have its tray of batteries pushed from the table into the battery compartment or pulled out of the latter on to the table. These operations are performed by means of hydraulic rams from a point centrally located behind the table. This hydraulic machinery is shown in the illustration.

Under each of the two parts of the moving vehicle platforms hydraulic cylinders are vertically placed. The plungers are attached to suitable raising bars, upon which the vehicle body rests while loading. These parts are normally below the surface of the platform, but when actuated are projected through an opening about in the centre of each half, which is covered by a series of small hinged trap-doors. These rams raise the vehicle, and when the elevating plunger parts are projected upward, the battery compartment is raised clear of the springs by the one and the hansom body by the other. After the vehicle body has been lifted, which constitutes the first operation, the side alignment is accomplished by means of other rams operated on either side of the loading platform. These bars act at about the hub centres of the wheels and extend horizoutally so as to strike both steering and driving hubs close to each end. The bars are connected to the plungers of the horizontally placed ram cylinders.

The two centring rams attached to each bar have different movements, the one opposite the front wheel having a travel of 11 inches, and the other one 7 inches. Both the lifting and centring rams act in one direction only, being returned to their normal position by heavy weights. The hydraulic rams and lifts are all mounted on solid masonry piers, and their movement is a definite predetermined amount, and raises and centres the vehicle to exactly the desired position.

In the rear of the conveyor table, placed horizontally in line with the centre of the loading platform, is a long hydraulic pushing and pulling ram; its cylinder is on a level with the top of the conveyor table, across which the long plunger is projected, and in the loading operation simply pushes the tray into its compartment. If the battery is to be unloaded the plunger is extended so that a pair of hooks at its ends automatically engage with sockets on the end of the tray, and the return of the plunger pulls the tray on to the conveyor table. The hooks are released by means of a lever at the rear side of the table, which is accessible to the man in the crane cab. After loading or unloading, the hydraulic machinery is returned to its normal position, and the vehicle leaves the platform.

Having carried the battery to the conveyor table, the crane operator finds himself directly in the centre of the latter, and at this point are the handles for its manipulation and the valves controlling the hydraulic cylinders, all of which can be operated without stepping from the crane cab. His position in the crane cab enables him to easily watch the lamps on the charging panels. The batteries are transferred from one line to another by bringing them to the conveyor table and shifting them in line with any hoist. The crane, which was made by William Sellers & Co., of Philadelphia, is operated by Westinghouse four-pole motors, each of 5 H. P. capacity. This arrangement makes all the motors interchangeable. For the operation of the crane bridge and the conveyor table a double motor equipment is used, which further insures continuous operation. The current for the crane motors is taken from the trolley wires suspended above the crane bridge.

For the operation of the hydraulic machinery an electrically operated Gould triplex pump is used. This pump is placed at the wall end of the conveyor table and feeds a pressure tank, from which pipes are extended to the various controlling valves, located as has already been described. The water is taken from a tank 3 feet in diameter and 5 feet deep, sunk in the floor between the loading platforms, and is returned after being used. The working pressure is 150 pounds to the square inch.

In addition to the loading stations just mentioned, an emergency loading station has been provided at the side of the battery room between the two vehicle elevators. No arrangement is made at this station for side centring, but the lifts and loading cylinders are arranged as in the others. At this station the battery tray is carried on a car to the rear of the vehicle, where it is handled by a loading and unloading ram, as previously described. The tray-carrying car runs on a track extending from this loading station transversely across the battery room, and the handling of the battery by the crane from and to the car will be obvious from prior description. The car with one tray can be set in line with any of the eight rows of battery racks.

The operation of the elements of this machinery is greatly aided by a number of interlocking safeties. On the crane an interlocking device coacts with notches in the track girder and only permits of operating the hoists when they are properly centred over the battery racks or the conveyor table The hoisting motors are also locked with the crane bridge motor, so that the latter can only be operated when all the hoists are up and clear from obstruction. The conveyor is provided with automatic motor stops at each end, so that the battery cannot be carried over the ends, and it is also interlocked

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with the loading machinery, so that the conveyor can not be moved when the loading ram is in action, or vice versa.

There are two vehicle elevators operated by worm gear electric motor drum hoisting machines. Each elevator has a capacity of 2½ tons and operates at the rate of 100 feet per minute. They are controlled by rope-operated starters.

Aside from the loading and unloading, the handling of the vehicle is simply a matter of unskilled labor. If the vehicle is to be stored after unloading, it is washed as any other carriage would be and sent to the upper floor by the rear elevator. As the vehicles are wanted they are lowered by the forward elevator. Each cab is inspected by the starter before leaving the station and a record taken of its battery equipment.

With the desire to increase the efficiency of the service, a series of vehicle tests will shortly be inaugurated. This will include tests of current consumption under different conditions of running, speed on grade and level, and traction tests. Various special and standard instruments have already been arranged for this purpose.

Rates of electric cab hire are about one-half those of the horse-drawn service; for each single passenger 30 cents for the first mile and 15 cents for each succeeding mile is charged, or the cabs may be hired by the hour at special rates.

The Electric Vehicle Company's officers are: Fred. Vieweg, general manager, and G. Herbert Condict, chief engineer. The superintendent of the plant is W. T. Headley, and the constructing superintendent, A. W. Gilbert.

CONDUCTORS.

TRANS-AFRICAN TELEGRAPH LINE.

A telegraph line from Cairo to Cape Town, in Africa, is talked of, with Mr. Cecil Rhodes as chief promoter, according to "The Engineering and Mining News." The proposed route would be from Fort Salisbury to the Zambesi, near Tete; thence to Zomba and along the west coast of Lake Nyassa to Karonga and Lake Tanganyika. At the latter point it would be necessary to lay a cable to the head of the lake, or obtain the permission of Germany or the Congo State to run an overland line through that territory. A telegraph line is now said to extend as far north as Lake Tanganyika; and from Cairo south it almost reaches the site of old Khartoum, or the junction of the Nile and the Atbara.

VACUUM TUBE LIGHTING.

VACUUM TUBE LUMINOSITY.

Mr. Ewin S. Ferry's communication to the "Physical Review" on the relations between pressure, current, and luminosity of the spectra of pure gases in vacuum tubes is a most valuable one. The author describes his methods fully, and gives his results in a series of tables and curves, which lead to the following conclusions regarding the luminosity of the separate spectral lines of gases in vacuum tubes under different conditions of pressure and current strength: (1) With gas pressure of from 0.25mm. to 4.00mm. of mercury, and current strengths of from one miliampere to six miliamperes, the luminosity of the separate spectral lines of gases at a given pressure is directly proportional to the current strength. This is in exact parallelism with K. Angstrom's observation that the energy of the luminous radiation, as well as the total radiant energy of a gas rendered luminous by an electric current, is directly proportional to the current strength. (2) With constant current, the luminosity of a spectral line of a gas increases as the pressure decreases, at first slowly and then more rapidly. The curve showing the relation between the pressure of the gas and the luminosity of a spectral line is regular, but is different for different lines. The research work was performed in the Physical Institute of the University at Upsala, and in conclusion the author expresses his deep obligations and grateful thanks to Prof. Knut Angstrom for the assistance and encouragement he received from him throughout the entire course of the experiments. To experimenters in vacuum tube lighting the possession of exact data is invaluable. The illuminating power of a gas as compared with the electrical energy consumed to produce that illumination being known, the problem of vacuum tube lighting at once assumes a position relieved of empiricism. A volume on vacuum tube lighting, its past and present, would be well received by the profession. The English Electrical Engineer, by interpreting the above, have certainly placed many readers of electrical literature under obligations to them.

WATER POWER INSTALLATIONS.

LONG-DISTANCE POWER TRANSMISSION PLANT

A contract involving 10,000 H. P. to be transmitted over a distance of 45 miles, and further stipulating that the losses in generators, transformers and line shall remain normal, notwithstanding the difficulties involved, has just been executed by the Westinghouse Electric and Manufacturing Company. The plant is for the Snoqualmie Falls Electric Power Company, of Snoqualmie Falls, Washington. The power station is to be located at Snoqualmie Falls, 45 miles from Tacoma and 31 miles from Seattle, to which places the current is to be transmitted and then utilized by Westinghouse motors. The contract involves the building and delivery of four three-phase rotary armature generators, having a normal aggregate capacity of 6,000 kilowatts, and which are to be direct-connected to water wheels; two 75 kilowatt kodak exciter dynamos, also to be direct-connected to water wheels; high and low potential switchboards for main power station and sub stations at Seattle and Tacoma, requiring 76 marble panels, with all necessary instruments, switches, etc.; high-tension oil-insulated static transformers, having an aggregate capacity of 10,875 kilowatts; rotary transformers, with a total output of 2,700 kilowatts, and 6 type C motors, developing 1,600 H. P., with adequate lightning protection at both ends of the line. These machines, when installed, will make available for industrial, railroad and lighting purposes the power of Snoqualmie Falls. The line potential will be 25,000 volts, and its current will be carried over bare aluminum wires to sub-stations, where lowering transformers will sufficiently reduce the voltage for safe transmission within the corporate limits of the two cities. The "Engineering and Mining News" prints the above. The use of aluminum conductors marks a decided innovation in power transmission plants.

ALTERNATING CURRENT MACHINERY.

"TRANSFORMER ECONOMY."

By Professor Goldsborough, of Purdue University, Lafayette, Indiana.

The new company has been in operation two years, and its plant is thoroughly up-to-date and highly efficient. Oil-insulated transformers of from 80 to 200 lights' capacity are used, and are kept in continuous service. The transformers are of modern design and stand an insula-

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tion test of 7,000 volts, without oil. The lines of the new company run over those of the old company and are protected about every 1,500 feet by lightning arresters. None of the secondaries of these transformers are, however, grounded, and magnetic shields are not used. The new company has never experienced any trouble from burnouts of any kind, although its lines are very much exposed. In a very violent electric storm which occurred some time since, in which the service of the old company suffered in consequence of transformer burnouts, the service of the new company was not interfered with in any way, although lightning struck the lines several times.

There has been a great deal of interest expressed recently in the effort to formulate a definite set of specifications covering the construction and insulation of transformers, with the end in view of decreasing the fire hazard and supplying the necessary protection from loss of life and property to both the producer and consumer of electrical energy.

In a letter that I have lately received from a gentleman who is much interested in the success of this project, he says that after corresponding with a number of makers, engineers and lighting companies to obtain suggestions as to the remedies for the troubles arising from crosses, lightning, insulation, break-downs, etc., the results were very unsatisfactory, as there seemed to be a vast difference of opinion.

I have read a great many articles for and against the use of earthing devices, grounded shields and grounded secondaries, but I am yet to be convinced that the prominent American practice of high insulation resistance to a disruptive discharge and a plentiful use of well-grounded short air-gap lightning arresters does not give a sufficiently good protection.

As I have already remarked, the number of modern transformers that are reported as burning out is relatively very small. By far the greater portion of the troubles arise from crosses between the high and the low potential circuits, and in such cases the loss must be attributed to faulty installation and not to any imperfection in the transformer.

An oil-insulated transformer for use on 2,500-volt primary circuits, or less, having a maximum temperature at full load not exceeding 65 degrees C. and designed to stand an insulation test without oil of 750 volts for five minutes, and a prolonged test of 10,000 volts with oil, will be in slight danger fram lightning discharges if protected within a distance of 500 feet by a properly installed lightning arrester.

A transformer should also be able to stand a double primary potential test for five minutes, and the insulation test should be made between the coils aud between each coil and the core.

In the case of transformers to be used exclusively on very high voltage circuits these considerations do not apply, nor should this paper be considered as dealing with this class of alternating apparatus, which has come to form a department by itself.

In considering the economy of transformers, the problem before us is not so much a discussion of their efficiency as a converter of electrical energy, as it is a discussion of this efficiency in connection with the numerous extraneous causes that tend to make the transformer a menace to life and property.

To my mind a great deal would be gained if an understanding could be brought about between the makers and purchasers of transformers that would result in a uniform practice in the several departments of transformer design. The manufacturers would work to better advantage by having definite specifications to work to, and the way would be open for a bonus or forfeit in equitable proportion to an excess or shortage in the economy of the product. The fad at present tends to over protection. It is bad practice to run to extremes in any department of engineering, and too much protection may turn out to be just as costly as too little.

ELECTRIC STREET RAILWAYS IN EUROPE.

On January 1st, 1898, there were 204 lines of electric street railways, with a mileage of 2,259.4 kilometers in operation in Europe. The rolling stock consisted of 4,514 motor cars. Germany has 65, France 44, Austria-Hungary, 13, Great Britain 24, Switzerland 23, and Italy 11, electric street railways. The system most in use is the overhead trolley, which is operated by 172 lines, while 8 lines have adopted the underground trolley, 8 lines the third-rail system, 13 lines storage or accumulator cars, and 3 lines have a mixed system of overhead trolley and accumulators at certain points of their lines.—U. S. Consul-General De Bois, Switzerland.

STREET RAILWAY NEWS.

Annapolis, Md.—A new electric railway is to be built to run from Baltimore through Anne Arundel County to Gibson's Island or Mountain Bar. Capital stock of the company is placed at $50,000.

Richmond, Va.—City Clerk of King William may give information concerning proposed erection of electric railway from Richmond through Henrico, Hanover and King William.

Portland, Ind.—The Portland & Camden R. R. Co. has been incorporated by Frank S. Vine, James Droege and others; to operate an electric railway between Portland and Camden. Capital stock, $50,000.

St. Louis, Mo.—The Electric Connecting Railway Co. has been incorporated by John H. Bobring, J. D. Houseman, Jr., and otl ers; to build and operate an electric line to Kimswick and De Soto. Capital stock, $2,000.

Gaston, Ind.—Ozora Sharp is reported to be interested in the construction of an electric line in this city.

Millbury, Mass.—The construction of the new electric road between Grafton and Worcester has begun.

Grand Rapids, Mich.—An electric road between Grand Rapids and Belding is being talked of.

POSSIBLE INSTALLATIONS.

Crescent City, Fla.—The Pierpont Manufacturing Co. has been granted an electric light franchise for a term of twenty years, the town having the privilege of purchase at the expiration of ten years.

Kingwood, W. Va.—City Clerk may be addressed concerning establishment of electric light plant.

Pratt City, Ala.—P. C. Shook and others have been granted franchises to erect an electric light plant, etc. The plant will cost about $10,000.

Florence, Ala.—The Florence Milling Co. contemplates establishing an electric light plant.

Opelika, Ala.—The Mayor may be addressed concerning contemplated erection of electric light plant.

Dalton, Ga.—City Clerk may be addressed concerning establishment of electric light plant.

Sturgis, Ky.—City Clerk will give information concerning establishment of an electric light plant.

Oakland, Md.—The Mayor may be addressed concering purchase of electric lighting plant, for which $25,000 has been issued.

Asheville, N. C.—F. M. Miller, Mayor, may be addressed concerning contemplated purchase of electric light plant.

Lumberton, N. C.—E. K. Proctor, Jr., Mayor, may be addressed concerning erection of electric light plant.

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Wharton, Tex.—G. C. Gifford has been granted franchise for lighting and water supply, and will at once arrange for erection of electric light plant.

Fredericksburg, Va.—The Mayor may be addressed concerning erection of municipal electric light plant.

NEW INCORPORATIONS.

Trenton, N. J.—New Jersey Washington Light Co. has been incorporated by E. Raymond Perrine, Richard H. Page, Horace M. Royal and others; to operate a system of lighting. Capital stock, $100,000.

Lincoln, Ill.—The Lincoln Gas Co. has been incorporated by F. B. Ferguson, George Skinner and others; to furnish gas and electricity. Capital stock, $10,000.

McKinney, Tex.—The McKinney Electric Light & Motor Power Co. has been incorporated by L. A. Scott, J. T. Nunely and D. T. Perdue. Capital stock, $17,000.

Philadelphia, Pa.—International Incandescent Light Co. has been incorporated, with a capital stock of $1,000,000.

Elizabeth, N. J.—The American Auto-Mobile Company has been incorporated, with a capital stock of $500,000; to manufacture motors and other electrical devices.

TELEPHONE CALLS.

Albion, Mich.—The Calhoun County Telephone Co. has commenced operations.

Urbana, Ohio.—The Urbana Telephone Co. has been incorporated by D. B. McDonald, Edward L. Barber, James S. Bradley, Jr., J. H. Dimond, E. M. S. Huston and others. Capital stock, $30,000.

Washington, Ga.—Ben A. Neal and Clark Grier have obtained franchise for, and will construct, a telephone system in Washington

BUSINESS CHANGES.

Stevens Point, Wis.—The Stevens Point Lighting Co. plant has been placed in the hands of a receiver.

Chicago, Ill.—Diamond Electrical Co., manufacturers of electrical supplies, closed on executions, $10,000.

Troy, N. Y.—The Hudson Electric Light & Power Co. has passed into the hands of Charles J. Cooper, of Brooklyn.

EXTENSIVE WATER WORKS DEVELOPMENT AT KANAWHA FALLS, W. VA.

Every arrangement has been completed, says the "Manufacturers' Record," for the development of the water power of the Kanawha Falls, located near Hinton, W. Va., and the work is now progressing rapidly under the direction of Mr. John W. Hayes, of Petersburg, Va.; Mr. Hayes also prepared the plans for the development.

The power is being developed by the Wilson Aluminum Co., of 97 Cedar street, New York. This corporation began operations several years ago at Spray, N. C., where it was the first to manufacture the calcium carbide now so extensively used in the production of acetylene gas. The company's business outgrew the power at Spray, and then a removal was made to Holcomb Rock, Va., and when it was seen that this power would not suffice it was determined to develop the power at Kanawha Falls, as noted above.

It is proposed to make two developments at the falls, 2,000 horse power to be developed on the north side and 5,000 on the south side, and it is stated that the conformation of rock about the falls renders this dual development expedient. The Kanawha River at the falls is about 1,600 feet wide, and is crossed by that hard ledge of sandstone known as the "Homestead," of Pennsylvania. The ledge forms an island rock rising six to eight feet above the water on the upper side of the falls and about twenty-six feet above the water below the falls, extending across the river, except at each side, where the river passes through a narrow channel and plunges over the crest of the ledge in falls of twenty feet height. At each of these falls the natural dam formed by the great rock will be completed by masonry and a head of twenty-six feet developed. The power of the Kanawha here is about 8,000 horse power (actual), varying from 6,000 to 12,000, with short seasons of greater variation.

The constructors are now engaged in extending the natural dam across the north side of the river, and this section is all that will be undertaken this season. A part of the season's work will be the installation of the wheels and the erection of the buildings and machinery necessary for the manufacture of calcium carbide. It is probable that the Wilson Aluminum Co. will require all the power developed for its own use, and therefore no electricity will be furnished to other industries.

"When times are dull and people are not advertising," says John Wanamaker, "is the very time that advertising should be the heaviest." Ninety-nine out of every hundred merchants advertise when there is least need of it, instead of looking upon advertising as the panacea for their business ills.—New England Editor.

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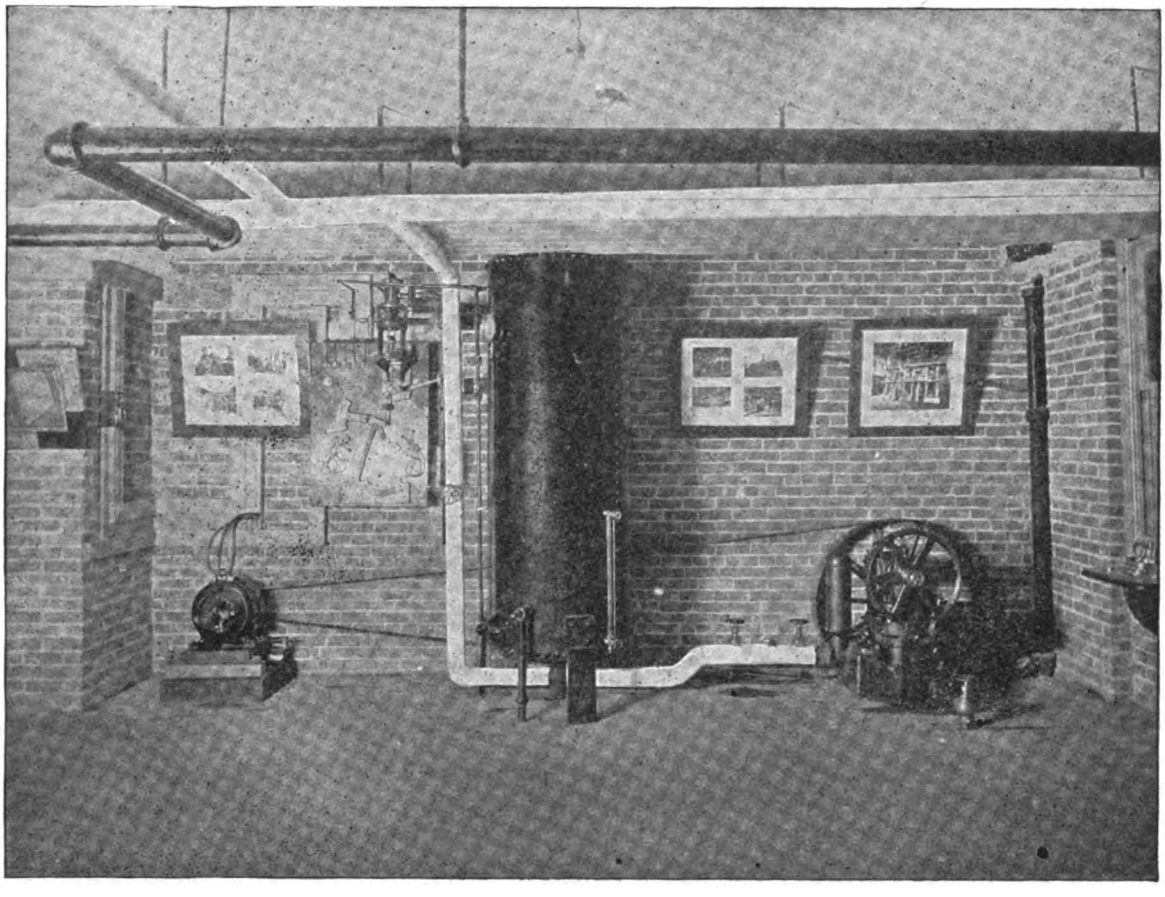
The Electrical Age.

VOL. XXII—No. 16 NEW YORK, OCTOBER 15, 1898 WHOLE No. 596

ELECTRIC PUMPS.



Automatic Electric Pump—Compression Tank System. Goulds Electric House Pump, Driven by Lundell Motor, Supplying Water to the Offices and Also to Operate the Automatic Elevator Gates in the Ferguson Building, Detroit, Michigan.

ELECTRIC POWER PUMPS.

The application of electricity for the operation of pumps has become a fixed part of engineering practice. A variety of purposes open up new and broadening fields, in each of which the electric pump finds a permanent position. Pumps may be used in connection with domestic service, in the engine room, in the mine, and for many other purposes. To enumerate, the following applications present themselves, in which pumps direct-connected to electric motors are operated noiselessly and economically. Pumping may be done with the electric house pump, the electric pump for hydraulic elevators, the electric pump supplying water to mills and factories, the electric boiler feed pump, the electric fire pump, the electric pump for mining. It may also be used for electric fountains, and in certain other instances it operates with a success that admits of no criticism.

The automatic electric house pump, run by a Crocker-Wheeler motor, connecting with a Goulds triplex pump, having a capacity of one thousand gallons per hour, has been installed in the Scarborough Mansion, 221 W. 57th street, New York City. The open-tank system is employed in this case, as in any other where the tank may be placed in the upper part of the building, and is there supplied with a float and chain connecting with an automatic switch. The rise and fall of the water switches the current off and on through the medium of the float.

By the compression-tank system, which is used in hotels and office buildings, a closed tank is situated in the basement, adjacent to the pumping outfit. Both water and air are pumped into it, the air pressure in the tank forcing the water to the upper floors when required. The compression-tank system, consisting of a tank, Goulds' electric house pump, driven by a Lundell motor, and a small switchboard, has been installed in the Ferguson Building, Detroit, Mich. This system is excellent for supplying drinking water to offices. Outfits of from one hundred to twelve hundred gallons per hour can be readily procured.

For elevator pumping there is nothing superior to the electric pump. It is perfectly automatic, requires no care, and invites no additional cost. During the hot weather neither the boiler nor steam pumps need be kept going, the triplex electric pump taking care of itself. The two plans adopted for the control of automatic electric pumps are called the by-pass and the start and stop. With the elevator in constant use the by-pass is preferable. In this case both motor and pump are constantly operating. When the elevator is not in use the by-pass relieves the load. The start and stop plan is best if the use of the elevator is inconstant. In this case the pump and motor only run when the elevator is in use.

In the Berkshire County Savings Bank Building, Pittsfield, Mass., a modern elevator pumping system has been installed, in which Gould's triplex electric pump is driven by a Stanley alternating-current motor. In the city of De Kalb, Ill., near Chicago, the water supply has been pumped lately by Gould's electric pumps. The original cost with steam pumps was ten cents per thousand gallons. It is now less than five cents. Two triplex pumps are used, each respectively of seven hundred

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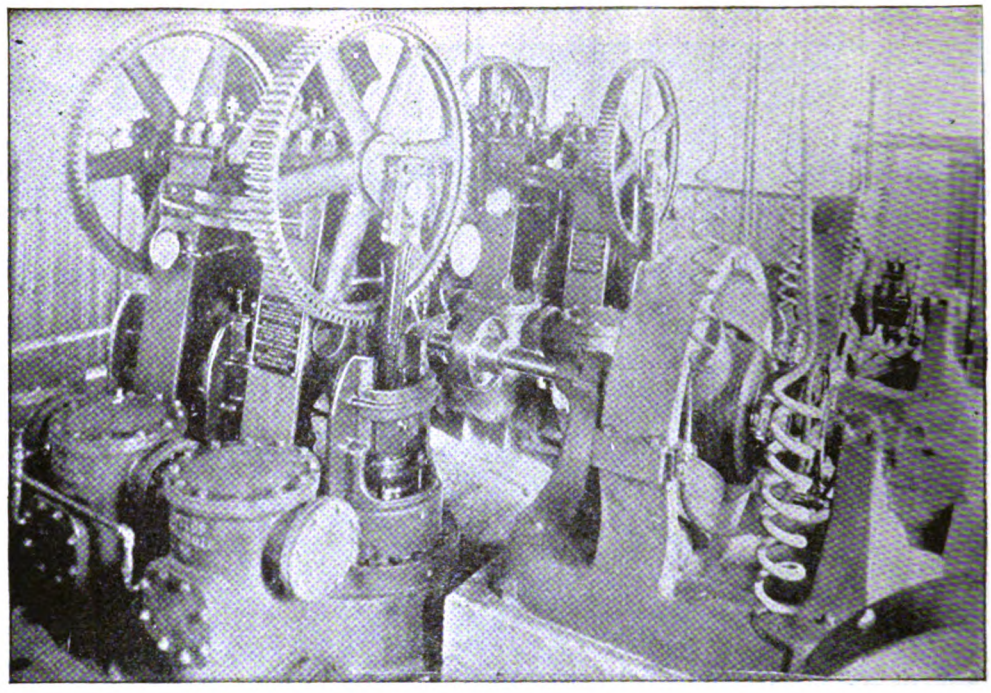
and fifty thousand gallons' capacity per day. General Electric motors are in use in this place. The electric light plant supplying power to this pumping station switch on the pump load when the stations are at light load.

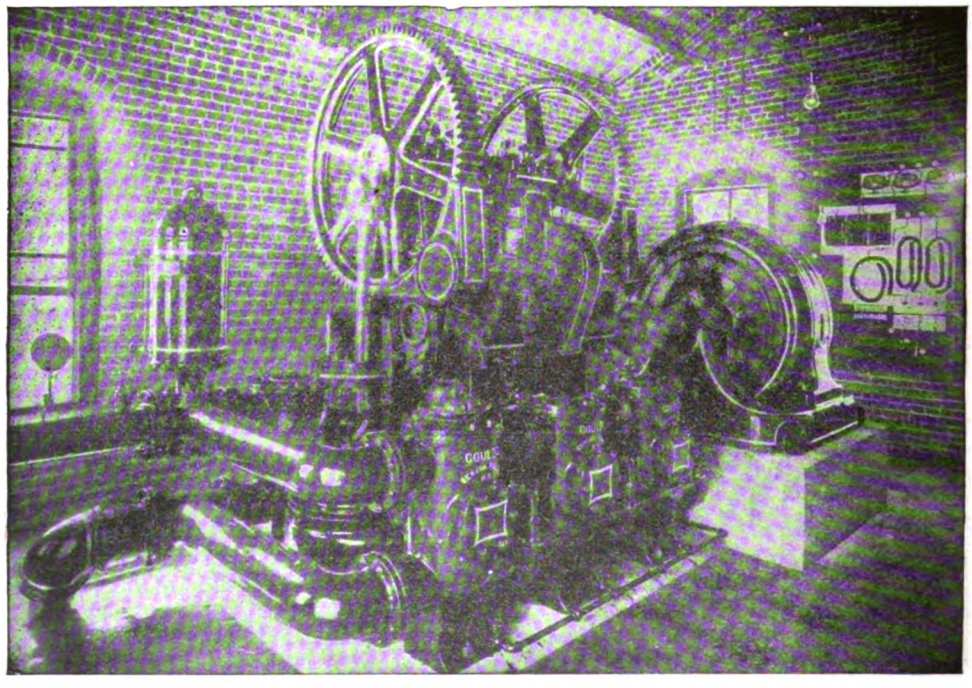


Electric Pumping Plant at De Kalb, Ill.

This means economy to them in running expenses and a reduced cost to the city of De Kalb.

When used as a fire protection, Goulds' electric fire pump saves considerable expense, inconvenience and risk. A pump of this description has been installed at Itaska, Wis., in the freight house of the Chicago, St. Paul, Minneapolis & Omaha Railraad. The severest tests have given favorable results. The freight house has connected at different points in its interior an electric switch and reel of hose, by means of which current can be turned and the pump operated at a moment's notice. Current is transmitted from the railway, about a mile and a half away. In every respect this installation has been successful and not caused one dollar of additional expense.

Street railways frequently increase their traffic by providing places of amusement for the people; the opening of parks and sea-side resorts and the running of electric fountains being included. In Willow Grove Park, near Philadelphia, the Union Traction Company, of that city, have built a beautiful electric fountain. It was designed by F. W. Darling, and the water is pumped into it by Goulds' triplex electric pumps, operated by two General Electric street railway motors. These motors are controlled in speed and capacity by rheostats, so that the output of the pumps equals eighty thousand gallons per hour. This application of electric pumps to fountains has so pleased the people's æsthetics that they are being erected in all of our large cities.



Goulds Electric Fire Pump at Itasca, Wis., in the Freight House of the Chicago, St. Paul, Minneapolis & Omaha Railway.

In connection with gas engines, the Goulds power pump has seen considerable service. In the case at hand, the Wyandotte Building, Columbus, O., a forty-horse-power gas engine drives a large Goulds double-acting pump.

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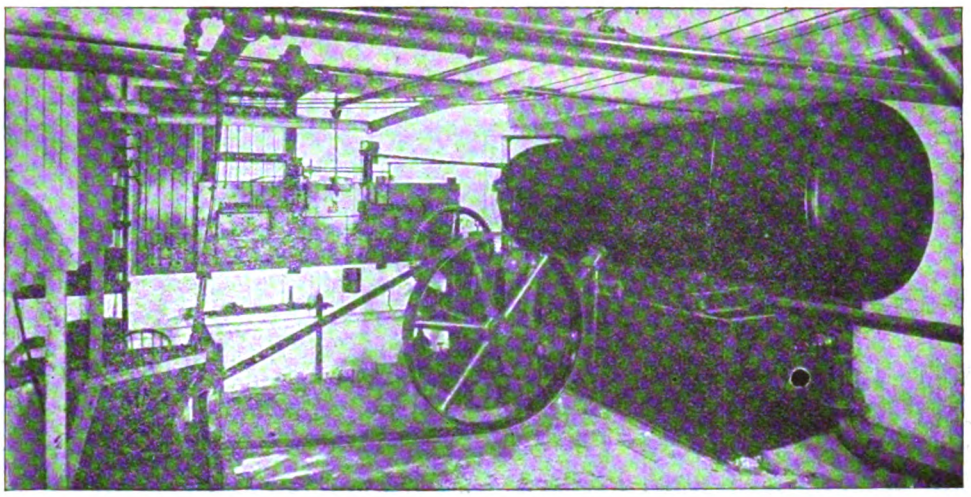
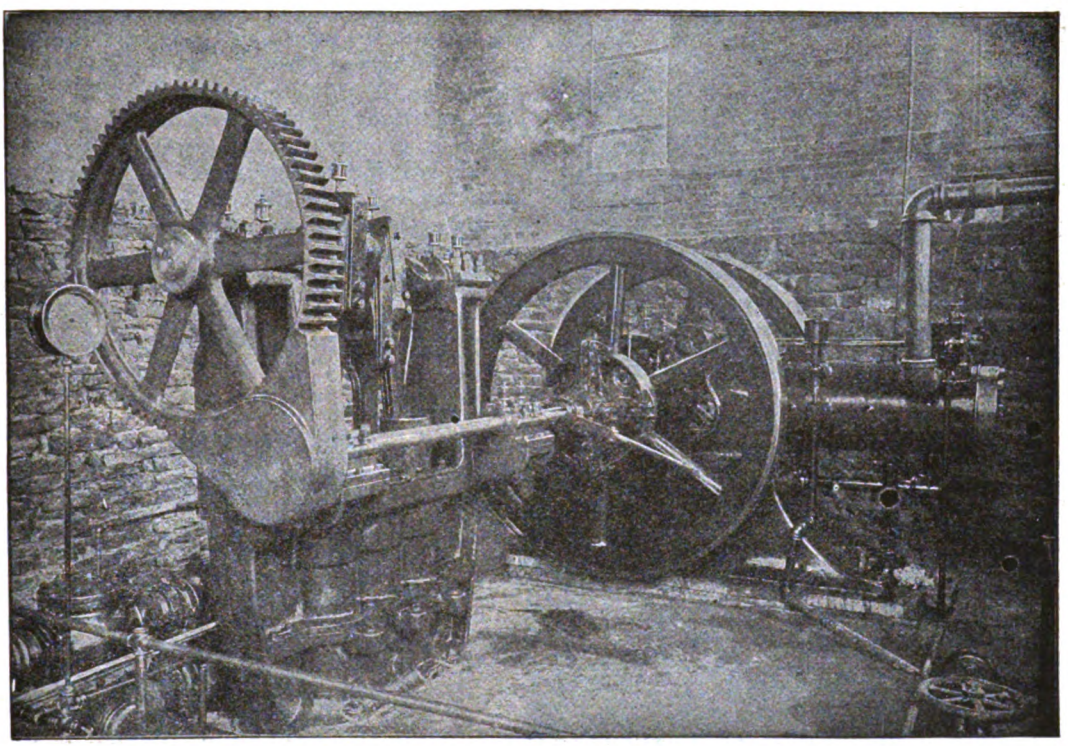
Natural gas is used in this case, costing only eighteen cents per thousand cubic feet. Two Otis elevators, running through seven stories on a one-minute schedule, are in constant use. The total expense for gas does not exceed $12.00 per month.

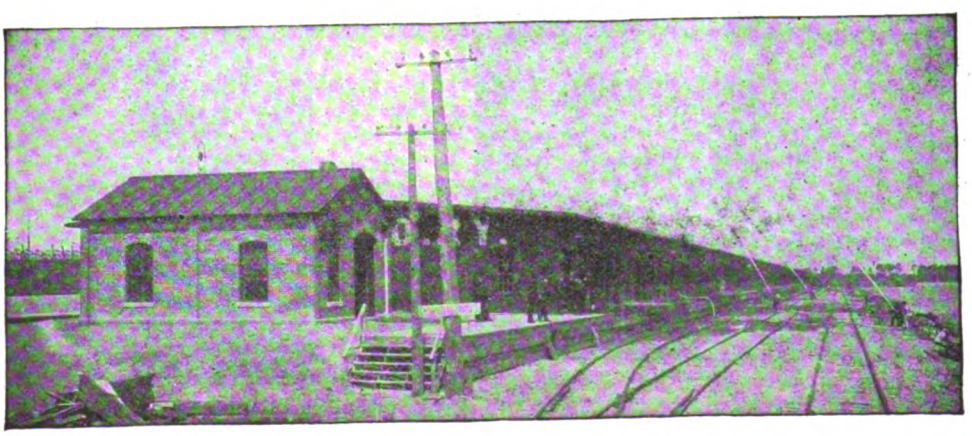
This exceptional case is noted, though not strictly



A Model Elevator Pumping System in the Berkshire County Savings Bank Building, Pittsfield, Mass. Installed by The Plunger Elevator Co. Goulds Triplex Electric Pump Driven by a Stanley Motor.



Goulds Triplex Power Pump, Capacity One-half Million Gallons Daily, at Lake Mills, Wis., driven by a Gasoline Engine, built by the Dayton Gas Engine Manufacturing Co. A Model Water Works Plant.



Goulds Electric Fire Pump at Itasca, Wis., in the Freight House of the Chicago, St. Paul, Minneapolis & Omaha Railway.

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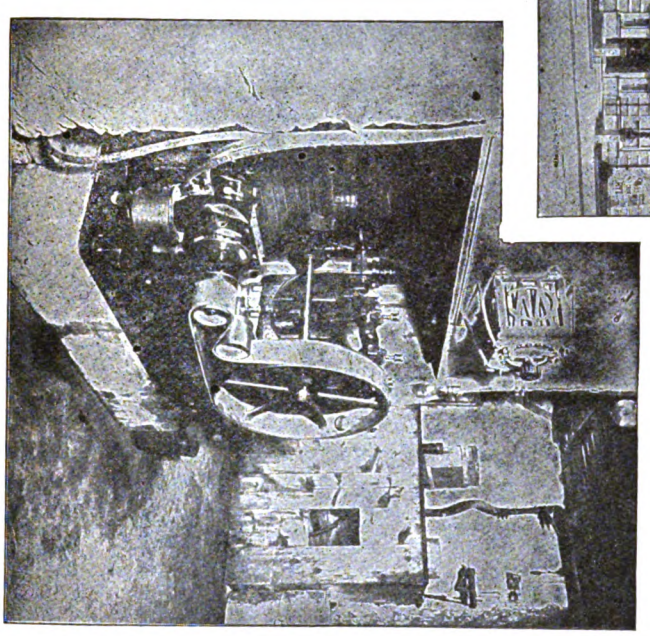
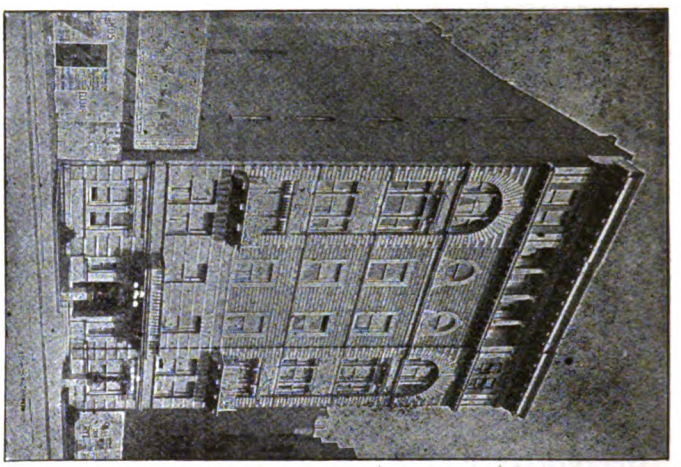
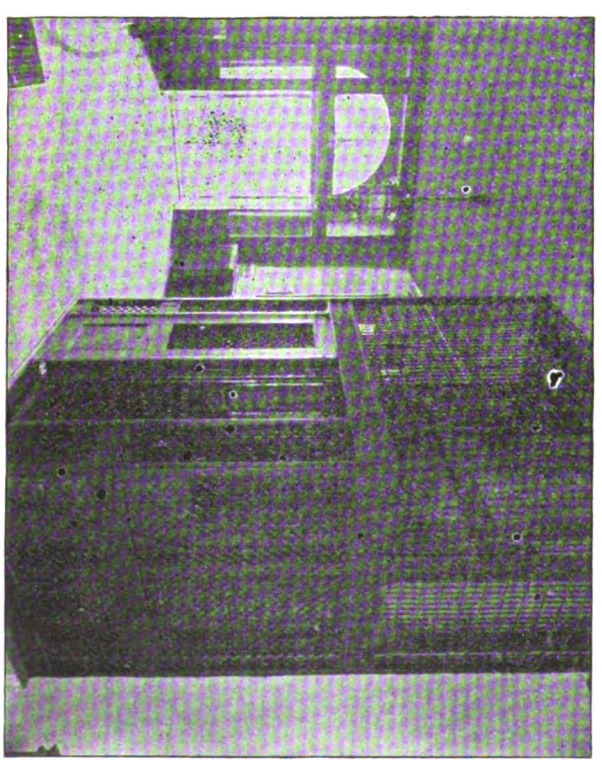
speaking, of interest to electricians, yet to those living in localities where natural gas is supplied the advantages are obvious.

The Goulds electric pumps are manufactured at Seneca Falls, N. Y.; the Boston office is at 8 Oliver srreet, the Chicago office at 22 and 24 North Canal street, and the New York office at 16 Murray street.

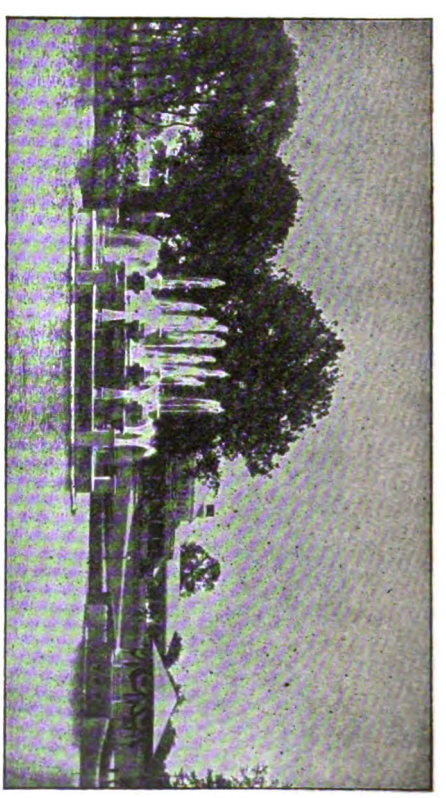


Goulds Triplex Electric House Pump with Crocker-Wheeler Motor. Capacity, 1,000 Gallons per Hour. In "Scarboro Mansions" 221 West 57th Street, N. Y.





Hydraulic Elevator Operated by Triplex Electric Pumps.



Electric Fountain, Willow Grove Park, near Philadelphia, Pa.

Iron City, Tenn.—The Lawrence Telephone Company is being organized.

THE TRANSMISSION OF ELECTRICAL ENERGY.

A FRENCH VIEW OF ELECTRICAL POWER TRANSMISSION.

Writing in the "Revue Générale des Sciences," M. Paul Janet would have every workshop, every warehouse, and even every workman's lodging or home provided with necessary power from some central point where such power can be produced under the best and most economical conditions. Other systems of power transmission, by cable, compressed air, water, all have their disadvantages; but the discovery of the reversibility of the dynamo gave a new aspect to the whole question. The efficiency of a transmission is reduced by three losses, which, to give fixity of idea, are set down as 10 per cent. in the generator, 10 per cent. in the receiver, and an amount in the line represented by $p = \frac{R P r^2}{E^2}$, where R is the line resistance in ohms, P is the power in watts, E the voltage, and r is the efficiency of the generator.

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THE ENERGY OF A LIGHTNING FLASH.

Higher and higher potentials are being used in power transmission plants. Pressures that could not have been handled with any degree of practical success are utilized and guided with perfect safety between points situated ten, twenty or thirty miles apart. Insulators have been improved in quality of late and can withstand potentials of thousands of volts without failure or depreciation of any kind. There is, of course, a limit to the use of very high pressures. The danger of sparking becomes very apparent when the pressure reaches fifty thousand volts. A power transmission line is more or less efficient, other things being equal, depending upon the pressure. The greater the pressure the greater its efficiency, and the lower the pressure the converse, unless a heavy conductor is used. The risks of leakage and the danger of sparking increase together. A pressure of thirty thousand volts is required to spark across a distance of one inch. But conditions have so much to do with the sparking distance that it might be safer to regard forty or even fifty thousand volts as the potential which will burst through a distance of one inch.

The sparking distance is affected by the nature of the light to which the terminals are exposed, as well as the pressure and temperature of the surrounding atmosphere. Electrostatic discharges a mile in length represent a pressure of millions of volts and a current strength of at least one hundred amperes. A flash of lightning one mile long means a pressure of discharge equal to three billion volts, if the basis of estimate is fifty thousand volts per inch of space. Although fifty thousand volts may be used in this calculation, it does not necessarily follow that a five-inch spark is produced by one-quarter of a million volts. If, however, a lightning discharge one mile long actually means a potential of three billion volts, possessing a current strength of one hundred amperes and lasting for one one-thousandth part of a second, the energy dissipated by the discharge equals three hundred thousand horse power. The amount of energy dissipated depends upon the electromotive force of discharge, the current strength and the period of time through which it lasts.

It is very likely that lightning discharges have occurred which meant the dissipation of at least one-half a million horse power, and possibly in some cases a million. We measure horse power by the rate at which energy disappears or is transformed. Consequently a tremendous outburst lasting for a fraction of a second is not of such awful consequence from a cold scientific standpoint.

Our present system of lightning rods is one which, strange to relate, forces a discharge to leave the earth in that given locality. The lightning rods force a discharge upward and, in certain respects, act homœopathically towards the surcharged aqueous vapor above. The multiplicity of these in the city in some way relieves each rod individually of the danger of fusing during a thunder storm. Another reason is one which brings in the element of time; the heating of a metallic body requires such time that even though a perfect avalanche of power is brought to bear upon it for a thousandth of a second, the time, if insufficient, will not cause fusing, although the energy applied for the instant would, if continued, resolve the body into its constituent atoms.

An interesting and valuable addition to our technical literature would consist of the results of experiments devoted to the discovery of the electromotive force required to cause a disruptive discharge between terminals exposed to ordinary light and the normal atmospheric pressure.

DYNAMOS WITHOUT MOVING WIRES.

It is considered a triumph of engineering to have constructed a dynamo without commutator or moving wires. The modern inductor alternator is just such a type of machine, and for practical utility and other obvious qualities has become an important factor in the application of electricity to lighting and power. The return from the more complex types of mechanism to the simpler is most natural. The ideal dynamo is certainly one simple in construction and durable in character. In the effort to attain other ends the dynamo, all types of which today are inherently alternators, were modified by the use of a current-rectifying commutator. Continuous-current machinery came into vogue, and this department of engineering represented all progress until the use of simpler alternating-current machinery, the application of polyphase currents and the invention of a system and motors for the distribution of such power added tremendous impetus to this new, though old, field.

Alternating currents were recognized as the most desirable for power-transmission purposes, and the employment of polyphase motors crowned this work with success. The inductor alternator came to the front and became recognized as an addition of tremendous value on account of its lack of commutator and the fact that no wires are moved during revolution. Out in mining camps, or in districts where engineering skill cannot be obtained, simple machinery counts for a great deal. This is one of the reasons why some inventor might turn his attention towards the construction of a continuous-current dynamo as commutatorless as the inductor alternator.

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Thus, with a power of 100 H. P. (French), or, say, 73,600 watts, and 10 ohms of resistance with 4,000 volts, the generator output being 90 per cent., we get the percentage of line loss

$$p = \frac{10 \times 73{,}600 \times 0.81}{16{,}000{,}000} = 3.7 \text{ per cent.} \qquad (1)$$

Hence the necessity of high voltage and small line resistance. The upper limit of the tension depends upon the possible difficulties in insulation of machines and of the line itself, difficulties which increase more rapidly than the tension itself. Losses from line are of two kinds, conductive and disruptive. The first are due to poor insulating material, and are most serious, being invisible, silent, and resembling the leakage of water from porous pipes. Damp air is the chief cause of such losses, or moisture on the line supports.

Disruptive losses may occur, no matter how dry the air, or how perfect the insulation, with a high tension. Disruptive discharges resemble the sudden rupture of a very impermeable water pipe, hard but fragile. There is a sort of electric fragileness. The subject was once looked on as rather in the domain of static electricity, and no fear was felt of disruptive discharges in the use of currents, but today electricians begin to encounter phenomena hitherto hardly seen outside the laboratory. Hence the necessity of limiting tension to about 20,000 volts. Line resistance can be diminished at will by increase of section. If d is the length in kilometres between two stations, the weight in *tonnes* of the two conductors will be

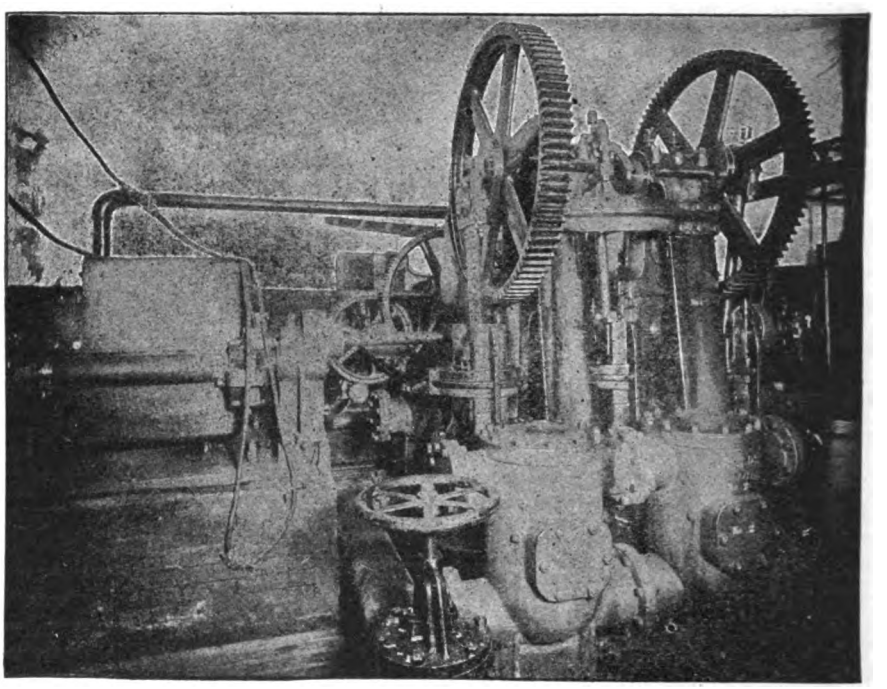
$$W = \frac{0.7\, d^2}{R} \qquad (2)$$

Thus for 10 kilometres and 10 ohms total line resistance the weight will be $\frac{0.7 \times 100}{10} = 7$ tonnes, which, at 2,000 francs per tonne (£80) will make the line cost £560. Combining the two foregoing formulæ, it is found that

$$W = \frac{0.7\, d^2\, P\, r^2}{p\, E^2}. \qquad (3)$$

Thus for a given distance, power, and voltage, the weight, and, therefore, the cost of a line varies inversely to the loss allowed, a heavy loss allowing an economy of copper, while a large locked-up capital in copper will reduce the line loss; hence Kelvin's law that "for a maximum economy it is necessary that the cost of the energy annually lost in the form of heating of the line should be equal to the interest and amortization charges of the capital represented by the copper in the line." The energy lost per second in the line is equal to $R\, I^2$ by Joule's law, I being the ampereage of the current. The cost of the energy lost annually is thus proportionate to $R\, I^2$, and may be represented as $k\, R\, I^2$. The weight and therefore cost of line is proportionate to $\frac{d^2}{R}$. Hence interest and sinking fund must be $k' \frac{d^2}{R}$. Applying Kelvin's law, we have in $k\, R\, I^2 = k' \frac{d^2}{R}$, whence $R\, I = \sqrt{\frac{k'}{k}}\, d$. But the resistance of a line depends on its length, and is inversely as its cross section; thus $R = k'' \frac{d}{s}$; whence $\frac{I}{s} = \frac{I}{k''} \sqrt{\frac{k'}{k}} = \text{const.}$

Kelvin's law thus leads up to the remarkable result that "to obtain the best conditions and most economical, the quotient of the current intensity by the line section—*i. e.*, the amperes per square centimetre—should have a value depending on the price of copper and of mechanical power, and on interest and sinking fund, but altogether independent of distance. The complete formula for current density is $\frac{I}{s} = \frac{1}{40} \sqrt{\frac{0.7\, a\, \alpha}{100\, p\, N}}$, where a is the price of copper per ton (in francs), α is the interest, etc.; p the price per watt-hour; N the annual number of working hours. Thus, to take a concrete example, as at Niagara, with copper at 1,350 francs, and interest at 5 per cent., and the price of a H. P. per year



The property of the Union Traction Company. The Electric Fountain was designed by F. W. Darlington. Water is supplied by Goulds Triplex Electric Pump driven by a pair of general electric street railway motors, with speed-controlling rheostats, varying speed and capacity up to 80,000 gallons per hour.

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75 francs, the best current density will be found to be about 55 amperes per cm^2.

The principal elements of a transmission scheme are now easy to calculate. Choosing the tension as high as possible, the line current intensity is immediately deduced, since the product of the intensity by the tension to the power transmitted is to the output of the generator.

Kelvin's law then gives the best density to adopt, and there is obtained immediately the section of the line and its weight. These elements fixed enable the costs to be approximately established.

It is not possible to fix, exactly, the price of machines. They may be set down at 100 to 150 francs per kilowatt (£4 to £6). This enables the cost of generators to be given, while the small economy due to line loss need not be taken into account in calculating the motors in a first calculation.

For the line, copper of highest conductivity should be employed, and cost may be calculated at once from the market price, which will be higher than that of ordinary copper. To this must be added the pole cost, and insulators, posts being spaced at 50 m. apart, and valued at 25 francs each, with their insulators (£1). Thus a kilometer will cost 500 francs (£20).

Thus to transmit 200 H. P. to 10 kilometres at 4,000 volts, with, say, 10 per cent. loss at the generator, 7½ per cent. at the motor, and 12½ per cent. in the line, or a total loss of 30 per cent. (the losses are given all in terms of the motive power), the line must weigh

$$\frac{0.7 \times 100 \times 200 \times 736 \times 0.81}{0.125 \times 16{,}000{,}000}$$

= 4.17 tonnes by the formula (3), which, at a cost of £80 per tonne, will amount to £334, while the poles, &c., will cost £200, making a total of £534.* The generator will cost, at £4 per kilowatt, £588, and, neglecting the small economy of the smaller motor, this may be set down at the same price, or a total for the two machines of £1,176, or a total for machines and lines of £1,710, to which five per cent. may be added for apparatus, making a total of £1,795 for the mere electric plant. For this there will be delivered 140 H. P. at the motor terminals; the cost is thus nearly £13 per H. P. The cost of the same installation at only 1,000 volts would be about £48 per H. P. delivered, which is sufficient to show the extreme importance of the highest possible voltage.

At first sight the advantage of transmitting a water-power lies in the fact that the power costs nothing. Nevertheless, with possession of a water-power goes the necessity of constructing dams, channels, gates, tunnels, turbine houses, &c., all which when set down as capital at an annual charge for interest and depreciation may represent an expense comparable with the cost of fuel. A few examples are given from actual practice. No 1. A fall of 100 metres and 4,000 litres per second in the Département de l'Isére. Power utilized 4,000 H. P.

The fall cost to acquire	£12,000
Dam, canal and pipes	10,000
Buildings and foundations	2,000
20 turbines of 200 H. P. each	3,200
Total	£27,200

The cost of power is thus nearly £7 per H. P. at the turbine shafts. In the Dpt. du Jura a fall of two metres, with 15,000 litres per second and 300 H. P. utilized, cost as follows:

Water rights	£1,800
Canal and building	6,000
Three turbines, each 100 H.P.	1,200
Total	£9,000

* 25 francs are translated as £1.

or £30 per H. P. at turbine shafts. These two examples are chosen as being particularly characteristic of extremes of high and low fall, and at once is seen the great benefit of using the maximum fall reasonably to be secured. In fact, nothing is so remarkable as the small size of turbines and plant necessary to utilize water at a high pressure. Of the first class of high falls may be cited the paper mills at Lancey, near Grenoble, where a fall of 500 m. has been utilized, while of the second kind the low falls of the Rhone, at Geneva, show what heavy work is necessary to utilize large masses of water at low falls.

Again, in Upper Savoy, a fall of 140 metres, giving a mean flow of 8,000 litres per second, and never falling below 4,000 litres, has been utilized. For three-fourths of the year some 11,000 H. P. is available, and in winter about 6,000 H. P. The value of this fall is estimated at £12,000, the work of installation at £20,000, including gates, dams, tunnels (one of 600, one of 650 metres in length), two m. high and 2.5 m. wide, canal, two steel pipes 1.40 m. diameter, and 500 m. long. Adding the turbine cost, say, £440, gives a total of £36,400 for 11,000 H. P., or only £3.32 per H. P.

In comparison with steam-power, the author gives an estimate as follows for 100 H. P.:

Engine	£800
Boiler, &c.	800
Building, &c.	400
Total	£2,000, or £20 per H. P.

(To be continued.)

TELEPHONIC.

TELEPHONE VS. RAILWAY.

The use of the long-distance telephone has diminished passenger travel on the railways. The extent of the loss suffered by the railways is not very well known and the importance of it is not admitted by all; but the newspapers have, now and then, given certain definite statements from well informed men, and there can be no question that the value of the telephone is increasingly appreciated. Another bit of significant evidence, reported to us on good authority, is the statement of a railway officer that the business of one of the limited trains between New York and Chicago has been practically ruined by the telephone. This comes from the chief executive officer of "one of the lines interested," and as there are only four or five roads interested in these trains, the reader can perhaps guess where the statement comes from.

This result is not very surprising. One of the definite objects had in view in putting on twenty-five-hour trains between New York and Chicago was the accommodation of brokers and business men of Chicago and the Northwest, who demanded quick time. Their trips to New York were taken on occasions of utmost importance, when a little time meant thousands of dollars. By means of the "Limited" the broker or business man was taken to New York in the quickest possible way. He talked as fast as he rode and made an equally quick return to Chicago. The business man was willing to pay the price assessed for this development in rapid transit.

The patronage of people whose time was less valuable to them was not expected to contribute much to the income of these trains, so that their whole dependence was expected to be, and was, on two classes: the business men aforesaid and pleasure travellers, to whom a few dollars extra was not a noticeable item.

Then came the introduction of the long-distance telephone. People at first were slow in realizing its benefits. Slowly but surely they have, however, come to appreciate its significance. A broker or a grain dealer in Chicago has in mind a "big deal;" he telegraphs to New York asking for certain information, and adds: "Call me

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up by long-distance telephone and give me your answer." The result is that for fifteen or twenty dollars a talk is held with the New York man. Having received the telegram he has had an opportunity to concentrate his expressions to the shortest possible statements; he has even jotted them down and at the proper time calls up his man and transacts his business. So it is done every day.

The railway president quoted said that in the past he had found it necessary to spend about twenty days of each month on the road, leaving but ten days of his time at his office. But now, by aid of the long-distance telephone, he has reversed matters; but ten days are required on the road, giving him twenty days in the office. Half-a-dozen grain men, who had been in the habit of making frequent trips between Chicago and New York, said that for three or four dollars they could now transact business which formerly required a three-day trip.—"Railroad Gazette."

WATER POWER INSTALLATIONS.

ST. MAURICE POWER.

The Contract for Improving That River Has Been Awarded.

Messrs. Barry, Ross and McRae have received the contract for the improvements on the St. Maurice River, which the Shawenagan Water and Power Company has in view. The intention is to develop electrical power from the 169-foot fall in the St. Maurice, and the work, when complete, will probably cost well on to a million dollars. A part of the scheme is an electric railway from the falls to Three Rivers, a distance of about 19 miles.

It is expected that work will begin within a month, and that some four hundred men will be employed in the construction. Among those interested in the enterprise are Mr. A. F. Gault, Mr. J. N. Greenshields, Q. C., ex-Mayor R. Wilson Smith, Mayor Prefontaine, Mr. D. L. Lockerby and Mr. J. Joyce, a wealthy Boston gentleman. Mr. Gault is president of the company.

The promoters state that transmitting the current from the falls of the St. Maurice to Montreal, a distance of 80 miles, is not by any means beyond the lines of possibility.

CONDUCTORS.

TELEGRAPH IN AFRICA.

Mr. R. D. Mohun leaves Antwerp this week with an expedition to construct a line of telegraph from Lake Tanganyika to Stanley Falls on the upper Congo, under the commission of the Congo Free State. Mr. Mohun was formerly Consul at Zanzibar. It is not yet known what purpose this new line is to serve; but it may safely be surmised that it is but a link in some larger enterprise. Mr. W. H. Cavendish is already in Africa at the head of an expedition to carry the line northward. No doubt he will reach the point from which the Belgian line starts, so that in two years from now, if all goes well, the Cape will have telegraphic connections with Stanley Falls—that is, the Cape-to-Cairo line will stretch more than half the length of Africa. But the wire already runs from Cairo to the present quarters of the Anglo-Egyptian army on the Atbara. It will be at Khartum within a period which may almost be measured by weeks. If any force pushes on beyond Omdurmam it will take the wire with it, and when the two years are completed the gap between the end of the line coming south from Cairo and the end of that running north from Cape Town will be much less than the distance from Khartum to Stanley Falls.—"St. James Budget."

RAPID CABLE LAYING.

The names of Lieut. W. C. Crutchley and C. Scott Snell, both Englishmen, are likely to become famous in military works if their plan of rapid cable laying proves to be all that it looks to be. The value of rapid cable laying in war can hardly be over-estimated, and it is a value which is more likely to increase than to decrease. In this new plan a cable is to be laid at the rate of twenty knots an hour, over a wheel on the ship's taffrail which is driven by a motor, and pays the cable out over the stern. Forward of this wheel is a wide drum, over which the cable passes on its way from the hold. In conjunction with the drum is maintained 2,000 feet of cable under constant tension.

The idea of a cable running out at twenty knots is rather startling, but experts are said to be of the opinion that this could be accomplished. The inventors have devised an apparatus for keeping it under control and completely stowing 2,000 cubic feet of cable. It is called the "Cable Accumulator," and is a small unit system of carrying the cable, which consists in placing the cable on board in drums of forty knots' capacity, and arranging them in columns, from which the cable is drawn off alternately; an automatic traveller to receive the cable as it leaves the drum and, finally, a controlling system, whereby an officer, located in a chart-room, keeps the attendant at the ejecting engine aware of the needed paying-out speed. The idea of the inventors is, that the officers on board a ship can induce currents in the cable without making actual metallic contacts with it. When the ship is right over the cable, messages can be sent along the wires, although there are no connections between the cable on the floor of the ocean and the instruments on deck. Recent experiments have shown that this can be done. There is no doubt whatever that the successful operation of such a rapid system would simplify some of the problems which now confront cable layers.—The Railroad Telegrapher.

ELECTRIC LIGHT AND POWER.

POSITIVE AND NEGATIVE ECONOMIES IN THE OPERATION OF SMALL ELECTRIC LIGHT PLANTS.*

It is generally considered quite sufficient to keep an account of expenditures and receipts, and to ascertain the amount of the balance at the end of certain periods, and if there is a balance, it is sufficient cause for jubilation.

Upon examination of a great many plants I feel sure that a great many of them, probably the majority, could reduce their operating expenses from 10 per cent. to 20 per cent. if—first—they were better informed as to the conditions under which they were operating, and—second—knew how to improve the conditions. It should also be noted that at the same time that reduction of expenses would be obtained, a better service would be given, with attendant better feeling on the part of the consumer, both public and private.

If we take up the consideration of the plant from the standpoint of a general superintendent, and desire to investigate its condition, we must first ascertain the useful results and the losses in each step, and then we can discuss changes either in the plant or in the handling of it, what such changes would cost, and the advantages resulting therefrom, and whether any or all shall be taken up.

We may start as follows:

1st. The production of power at the dynamo pulley.

2nd. The conversion of mechanical into electrical energy.

* A paper read by E. P. Roberts before the Ohio Electric Light Association.

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3d. The delivery of the electric energy to the various points where it is to be converted into light, heat or power.

4th. Its conversion as above stated.

Taking the above in order, we have first to consider the production of the driving power. In this case we will work backward, that is, from the dynamo to the coal pile. If the plant is not direct-connected, we will have belts and probably shafts.

Belts and Pulleys.

Are the belts tighter than advisable? If so, it may be because they are oily and dirty; this means increased depreciation as well as increased power. Evidently they should be cleaned. Possibly the belt centres are too close together, and this distance cannot be increased. Possibly larger pulleys can be placed, preferably (if not making belt speed excessive) larger in diameter, but if this is not feasible, wider in face. Will this pay? Suppose a belt transmitting 100 horse power costs $100, and is running too tight and adds 3 per cent. (3 horse power) to the friction more than it would do if running loose. Suppose to change to larger pulleys costs $75 and the extra belt costs $25 additional, making a total of $100. Probably the life of the belt will be increased 50 per cent., say nine years, as against six. We then have for twelve hours' run for 365 days and 3 horse power a total of 13,140 horse power hours. If the additional coal is 4 pounds per horse power, and coal costs $1.50, we will have a saving of $39.42 annually, and a lessened depreciation of $5.55, or a total of $44.97. Not only a saving of 45 per cent. on the investment, but also less probability of breakage of belt, of poor lights, because of slips, of hot boxes and consequent cost of renewals, and less oil (though same is not figured), and, most important, less probability of shut-downs. The above is only a small item, but how many managers would spend $100 to save a belt slipping? The station superintendent must get along with resin.

Possibly the only remedy applicable is a tightener, not a very desirable method, but generally 99 per cent. more objectionable, wasteful and noisy than necessary, because installed in the cheapest way possible.

Shafting.

In such a paper as this we cannot consider appliances in detail, so will pass on to the shaft. Here we find very little friction if the shaft is sufficiently stiff and in line, but if not, the friction may be from 15 per cent. to 20 per cent. of the rated load, and in many cases it is probably 10 per cent. more than necessary; therefore, for every horse power it transmits, it unnecessarily wastes in friction (if at the same rate as in previous example) $13.16 annually in fuel, a considerable amount in oil, and increases the liability of hot boxes. The remedy may be a new and larger shaft, or new and better boxes, or the present shaft may only need alignment. The trouble and its amount must first be ascertained and then the remedy applied. Suppose that the shaft transmits 200 horse power and loses only 5 per cent. more in friction than it should, how much can we afford to spend to save that 5 per cent.? The direct saving would be $131.30 annually, which would be 10 per cent. on $1,313.00, and this is the amount we could not afford not to spend, and without considering the incidental advantages.

(To be continued.)

Newark, N. J.—Atwood Power & Speed Gage Co. has been incorporated by George F. Atwood, Harry A. Fields and George R. Swain; to manufacture electrical and steam measuring instruments, etc. Capital stock, $75,000.

OPINIONS OF EXPERTS.

THE PRESENT STATUS OF ELECTRICAL ENGINEERING IN THE UNITED STATES.

By Dr. A. E. Kennelly.

By far the greater proportion of electric development has come within the past decade and a half. In a recent presidential address before the American Institute of Electrical engineers the writer pointed out, as illustrative of this, that in 1884 the words ammeter and voltmeter were just commencing to be generally recognized, and of electric traction there was none. At the present time the capitalization in electrical applications in the United States is estimated at $1,900,000,000.

In 1884 a 50 kw.-dynamo was considered a large machine, while a 100-kw. Edison steam dynamo was justly called a "Jumbo." At the present time the largest size of generator built or building is of 4,600 kw. capacity. The price of dynamos in 1882 was about 20 cents per watt of output, while dynamos of similar running speed in comparatively small sizes, without switchboards, now cost about two cents per watt. The great reduction in price represents the aggregate result of the very large amount of labor devoted to this branch of engineering in the last fifteen years.

It is interesting to notice that the efficiencies of continuous-current dynamos have not made any marked nominal advance during the past fifteen years, though their output per unit of mass has considerably increased. Thus a 50-kw. dynamo tested at the Philadelphia Electrical Exhibition in 1884 is stated to have had an efficiency of approximately 92 per cent., and this would be considered a satisfactory performance in that size of machine today. But, whereas the output then was only six watts per pound of net weight, the output of a machine of similar rating and speed today would be about ten watts per pound. In other words, the efficiencies of the best dynamos of 1884 were already so good that it has not paid, at existing costs of power, to markedly improve them, and such improvements in material and design as have since been effected have enabled the manufacturers to increase the rating or yield, and, therefore, the cheapness of the machines. It seems probable, moreover, that this will continue to be the direction of future progress. We scarcely can desire more efficient machines than the best we have now, but we shall always desire cheaper and more powerful machines, and shall welcome any improvements which lead to them.

Another evidence of the development in dynamo machinery is its improved appearance. Formerly the only claim possessed by such apparatus was utility. More recently grace, the expression of unconscious power, has supervened, and the modern dynamo is often pleasing to look upon, as well as useful to operate.

The cost of generating a kilowatt-hour of electric energy from steam for electric lighting appears to have been at least 7.5 cents at the 'bus bars in 1884. At the present time the cost of delivering a kilowatt-hour to large street railway systems from steam is only about one cent, and the power house operating costs are reported in some cases as low as half a cent. In municipal electric lighting systems supplied at low pressure from steam central stations and hampered by relatively heavy distributing expenses, the retail price of the kilowatt-hour varies from 20 to about 4½ cents, according to the locality and quantity consumed. Niagara power is now sold to consumers in Buffalo at rates varying, according to the amount delivered, from two cents to slightly less than two-thirds of a cent per kilowatt-hour delivered.

The price of a 16-c. p. incandescent lamp sixteen years ago was about $1. Now it is about 18 cents. The best lamps at that time, under laboratory conditions, gave about 0.28 mean horizontal normal British candle power

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per watt, and under commercial conditions about 0.20. The highest pressure for which they could then be obtained was about 110 volts. At the present time lamps are obtainable giving normally 0.4 mean horizontal British candles per watt, while under commercial conditions the average lamp normally develops about 0.25 candle per watt. They can also be obtained (at 0.25 candle per watt) for pressures up to 240 volts, and are frequently installed on 220-volt mains.

Arc lamps were already so far advanced in 1884 that comparatively little improvement in their effectiveness has taken place, the gain having been made in economy of operation. Thus the carbons which cost at that time about six cents apiece now cost about two cents apiece. The enclosed arc lamp has of recent years become popular, owing to its diffused light and a carbon life of from 100 to 150 hours.

It has been estimated that about $600,000,000 have been invested up to the present time in electric lighting stations and plants in the United States.

The best storage cells tested at the Philadelphia Exhibition of 1884 gave a yield, under laboratory conditions, of 3.4 watt-hours per pound of electrodes, with an energy efficiency of 69 per cent. when discharged at the mean current density of 12 amperes per square foot of negative plate surface; while the deterioration was comparatively rapid. At the present time storage cells are in use giving, under laboratory conditions, a yield of from five to six watt-hours per pound of charged cell, with an energy efficiency of about 85 per cent. when discharged at a current density of 4.8 amperes per square foot of negative plate surface. There are now storage batteries installed in the United States to the aggregate capacity of about 56,000 kilowatt-hours. The largest installation has 166 cells, weighs 500 short tons, and has an eight-hour discharge capacity of 22,400 ampere-hours, or 3,136 kilowatt-hours at 140 volts pressure.

A very great development has taken place in the direction of electric traction, by virtue of which the horse car, once so well-nigh ubiquitous in city streets, has almost entirely disappeared, while electric locomotives of 1,500 H. P. have even made their appearance on steam railroad tracks. The introduction of soft cast steel has been very advantageous to the electric motor, enabling its output to be increased from 5 watts per pound of net weight in 1864 to about 14 watts per pound in street car motors at the present time. It is estimated that there are today in the United States about 14,000 miles of electric railroad, with a nominal capital of about $1,000,000,000, and employing about 170,000 men.

The electric transmission of the power of falling water is a branch of engineering that has come into service since 1884, and is making rapid strides, owing to the recent successful employment of high voltages and multiphase alternating currents. It has been estimated that about 150,000 kw. of this class of machinery is installed on the North American continent, commercially transmitting power to various distances up to 85 miles at various pressures up to 30,060 volts.

The alternating-current induction motor has become very popular in recent years, mainly owing to its powerful starting torque and its freedom from commutator and brushes. A burned-out armature, the perpetual source of dread in motor operations of days gone by, is practically unknown in this style of machine, even when put to severe service. Indeed, its depreciation under fair conditions appears to be as low as in any class of rotating machinery.

The alternating-current transformer has been correspondingly improved, developing, in large sizes, an efficiency of about 98.5 per cent., and an output, when cooled by external power, of about 100 watts per pound of weight.

(To be continued.)

THE AMERICAN ENCLOSED ARC LAMP.

We invite attention to the accompanying illustration of the American Enclosed Arc Lamp, which has been recently placed on the market by Mr. Chas. J. Bogue, 213-215 Centre street, New York.

Mr. Bogue has had long and varied practical experience in lamp construction work, and this latest production of his long-burning enclosed arc lamp bids fair to rival in success his other numerous enterprises.

The American Enclosed Arc Lamp.

This lamp is very substantial in construction and specially designed to stand the roughest usage. The interior mechanism is simple and consists of but few parts, and there is nothing to get out of order. The question of trimming, always an important factor in enclosed arc lamps, has had special attention; the carbons can be placed in position without any trouble; the device for lowering the outer globe is simple and reliable.

The outer globe, it will be seen, is a perfect sphere, thus insuring an even diffusion of light without shadows. For outside service the finish is of japanned iron, and for inside use a variety of patterns are shown in fancy brass, polished or oxidized.

STRAY CURRENTS.

Electric power for sewing machines has formerly been applied from the motor to the spindle through gearing. The new German electric sewing machine has the power applied directly to the spindle. The spindle, which gives the reciprocating motion to the shuttle and needle, carries the armature of the motor. The field magnets are of soft iron, and the windings of the armature are in twelve sections. It is shunt wound, and there is a rheostat for regulating the speed, which can do so at any speed between 180 and 1,800 revolutions per minute.—Ex.

Mr. Lanz describes in "Wiedemann's Annalen" his researches upon the arc with aluminum electrodes. This arc is established under an E. M. F. of 19 volts. Between electrodes of aluminum and carbon the current passes more easily from aluminum to carbon, an effect contrary to that noticed in the electrolytic cell. This arc may be used, therefore, for the rectification of alternating currents, but the efficiency of such a rectification would not be higher than about six per cent.—Ex.

All who are interested in naval warfare will find the results of certain experiments, recently made with submarine search-lights on board an American vessel, worthy of some attention. The light streams through strong lenses from a point far below the water-line, and, taking a line almost horizontal, at last reaches the surface of the water, which it illuminates without betraying the position

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of its own ship. These submarine search-lights are capable of being used at various depths and in various directions, so that they can throw a light upon the whole surroundings of ships lying at anchor.—Ex.

By means of a powerful Crooke's tube and a fluorescent screen, it is easy to determine the purity of a fuel. Carbon, in all its forms, is exceedingly transparent to the rays, while silica and silicates are opaque; and, on placing a lump of coal between the tube and the screen, all the intimate details of the slag and clinker forming portions of the fuel at once appear.—Ex.

Franz Clouth, of Köln-Nippes, prepares electric cables with lead armors, which, at first sight don't appear to offer any novelty. The conductors are surrounded by rubber or gutta-percha and between this and the lead sheaf is insulating material. This insulator, however, does not consist of cotton, or jute, etc., impregnated with some chemical, but is a homogeneous insulating mass. The cable end need not be especially protected for preventing moisture from creeping up the fibre.—Ex.

Carl Schmidt, of Düsseldorf, clothes the insulating tubes or pipes of electric conductors with asbestos.—Ex.

A large submarine cable for the Western Union Telegraph Company has just been completed at Trenton, N. J. It is to be used for the transmission of messages beneath the waters of Puget Sound, between Port Angeles and Victoria. It is 29 miles in length, and is divided into two sections. One section is 20 miles in length and the other nine. The entire cable weighs 188 tons, and it was made at the rate of one mile per day. The cable is a three-conductor one, gutta-percha insulated.—Ex.

ELECTRIC RAILWAYS.

ELECTRIC RAILWAYS IN CANADA.

Sault Ste. Marie, Ont.—A charter for a steam or electric railway from this city to Michipicoten has been applied for.

Peterboro, Ont.—The Peterboro & Ashburnham Street Railway has been sold to Arthur Stevenson. It is probable that some improvements will be made.

Yarmouth, N. S.—There is said to be a possibility of the Yarmouth electric railway being extended to Port Maitland next spring.

Hamilton, Ont.—The City Council has decided to extend the franchise of the Street Railway Company for twenty years. As soon as financial arrangements are completed, some improvements will be made in the system.

St. Catherines, Ont.—Haines Bros., of New York, who have secured control of the Niagara Central Railway, announce their intention of operating the road by electricity. Various changes in the road-bed will be made and the trestle work at Meritton and Thorold done away with.

Ottawa, Ont.—There is a movement on foot to secure the extension of the Ottawa Street Railway through Britannia, but it is probable that the matter will not be taken up before next spring. The cost of the extension is placed at $125,000. It is also urged that the road should be extended to Rockland, a distance of 22 miles.

Hamilton, Ont.—Ratepayers in the district of Vineland have asked the Hamilton, Grimsby and Beamsville directors to extend the road to St. Catherines.

Darmouth, N. S.—A scheme is on foot to construct an electric railway from Waverley to this place, thence to Musquodoboit Harbor. A meeting of the promoters will be held shortly.

Chatham, Ont.—An electric railway from Ridgetown to Rondeau Park, near this city, is one of the probabilities of the near future.

J. ALCIDE CHAUSSÉ.

ELECTRIC LIGHTING IN CANADA.

CANADIAN ELECTRICAL NEWS.

London, Ont.—Five tenders were received by the city for the supply of an incandescent lighting plant, but the figures have not been made public.

Thorold, Ont.—The town invites tenders for an incandescent lighting plant of from 1,500 to 2,000 lights. Particulars from R. J. Parke, consulting engineer, Toronto.

Barrie, Ont.—Recently the ratepayers sanctioned a by-law to raise $35,000 for the installation of a municipal electric light plant. Tenders for the plant were taken some weeks ago.

Ottawa, Ont.—A company represented by T. Lindsay has applied to the City Council for permission to sell electric light and power within the city limits.

Pembroke, Ont.—The Council is obtaining information regarding the cost of installing a municipal lighting plant.

Campbellford, Ont.—The ratepayers have voted in favor of raising $8,000 for the installation of a new incandescent lighting plant to replace the one now in use.

Carberry, Man.—A representative of an electrical company is endeavoring to obtain from the town a franchise for electric lighting for 25 years.

Dundas, Ont.—The town has given a franchise for electric lighting to a local company, of which H. Harper is manager.

Rossland, B. C.—There is an agitation in favor of municipal ownership of the electric light and waterworks systems.

Dundas, Ont.—The by-law granting a franchise to the Dundas Electric Co. was passed at the last Council meeting. The company agree to furnish power by December 1st next.

Peterborough, Ont.—The Peterborough Light and Power Company has requested the Council to grant exemption from taxation on proposed improvement. The company intend to build a new power house. If the request is granted the Dickson Co. will deepen their raceway. The proposition has also been submitted that instead of building the London street bridge over the raceway 20 feet wide the town will make it 52 feet wide, on condition that the Dickson Co. will build the centre pier.

Brantford, Ont.—The Paris Electric and Power Co., represented by Messrs. Carroll & Smith, has requested permission to distribute electric power in this city. The company intend utilizing the water power of the Grand River by constructing a dam.

J. ALCIDE CHAUSSE.

POSSIBLE INSTALLATIONS.

Florence, Ala.—The Florence Cotton Oil Co. will install an electric light plant at its mill.

Crescent City, Fla.—C. H. Cash and W. J. Pierpont have petitioned for electric lighting franchise.

Covington, Ky.—The Mayor may be addressed concerning construction of electric light plant.

Saratoga Springs, N. Y.—Albert L. Judson, of Albany, has applied to the Board of Street Commissioners for a franchise for an electric light and gas plant to be established in this city.

Orangeburg, S, C.—The Mayor may be addressed concerning construction of electric lighting plant.

Wharton, Tex.—G. C. Gifford contemplates the establishment of an electric light plant.

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Utica, N. Y.—The plant of the Utica Electric Light Company will be enlarged.

Oakland, Md.—The Mayor may be addressed concerning the establishment of an electric light plant, for which bonds have been issued.

Kingwood, W. Va.—The City Clerk may be addressed concerning the establishment of an electric light plant.

Dalton, Ga.—The City Clerk may be addressed concerning the establishment of an electric light plant.

Lumberton, S. C.—The erection of an electric light plant in this city is being considered.

Laurel, Miss.—An electric light plant will be established here shortly.

STREET RAILWAY NEWS.

Jefferson City, Mo.—Sedalia Electric and Railway Co. has been incorporated by C. H. Reeve, J. C. Delong and others. Capital stock, $400,000.

Niles, Mich.—The Indiana Electric Railroad, now building a line from Goshen to South Bend, Ind., will extend the line through Niles to Chicago.

Springfield, Ohio.—An electric line is to be constructed from here to Dayton, and the capital stock of the Dayton, Springfield & Urbana Railway Company is to be increased to $1,000,000.

Sandusky, Ohio.—A syndicate of New York capitalists are reported to have a scheme on foot for the purchase of the Sandusky, Milan & Norwalk Electric Railway and the People's City Line.

Kansas City, Mo.—The Metropolitan City Railway Co. are making arrangements to change the power of its cable lines to the trolley system.

Knoxville, Tenn.—A survey for an electric road has been made between this city and Sevierville.

Cranford, N. J.—The Westfield & Elizabeth Railroad Company has been granted a franchise to build a trolley road through this town.

TELEPHONE CALLS.

Moundsville, W. Va.—Panhandle Telephone Co. has been incorporated, with a capital stock of $50,000.

Grafton, Va.—The Grafton Telephone Co. has been incorporated, with a capital stock of $10,000.

Bordentown City, Pa.—A new telephone company has been granted a franchise.

Amherst, Mass.—Amherst Telephone Co. has been incorporated, with a capital stock of $4,000.

Thomasville, N. C.—The Thomasville Telephone Co. has been incorporated by F. S. Lambeth, J. W. Lambeth, C. A. Julian, J. F. Haden and others; to establish a telephone system in Thomasville and the surrounding country. Capital stock, $6,000.

Fordsville, Ky.—Work will shortly be begun on the Fordsville-Hartford Telephone line.

Urbana, Ohio.—The Urbana Telephone Co. has been incorporated, with a capital stock of $30,000.

Athens, Ala.—The lines of the Athens Telephone Company are being extended.

Bridgeport, Vt.—The lines of the Champlain Telephone Company are to be extended across the lake.

New Orleans, La.—A new telephone system will be established in this city by the People's Telephone Company.

Providence, Ky.—A telephone exchange will be established.

NEW INCORPORATIONS.

New York, N. Y.—The Nilsson Power Co. has been incorporated by F. E. Mygatt, P. A. Brown and S. F. Patterson; to manufacture machinery. Capital stock, $5,000.

BUSINESS CHANGES.

Philadelphia, Pa.—The Southern Electric Light and Power Co. stockholders will hold meeting to consider the question of increasing the capital stock from $400,000 to $2,000,000.

Chicago, Ill.—E. D. Middlekauf, electrical goods, etc., gave chattel mortgage for $2,000.

Lancaster, Pa.—Orne Electrical Construction Co. has made an assignment. Assets and liabilities, $5,000 each.

Montevideo, Minn.—The Roller Mills and Electric Light Co. has been sold to the James Quirk Milling Co., of Waseca, for $13,500.

INVENTORS...

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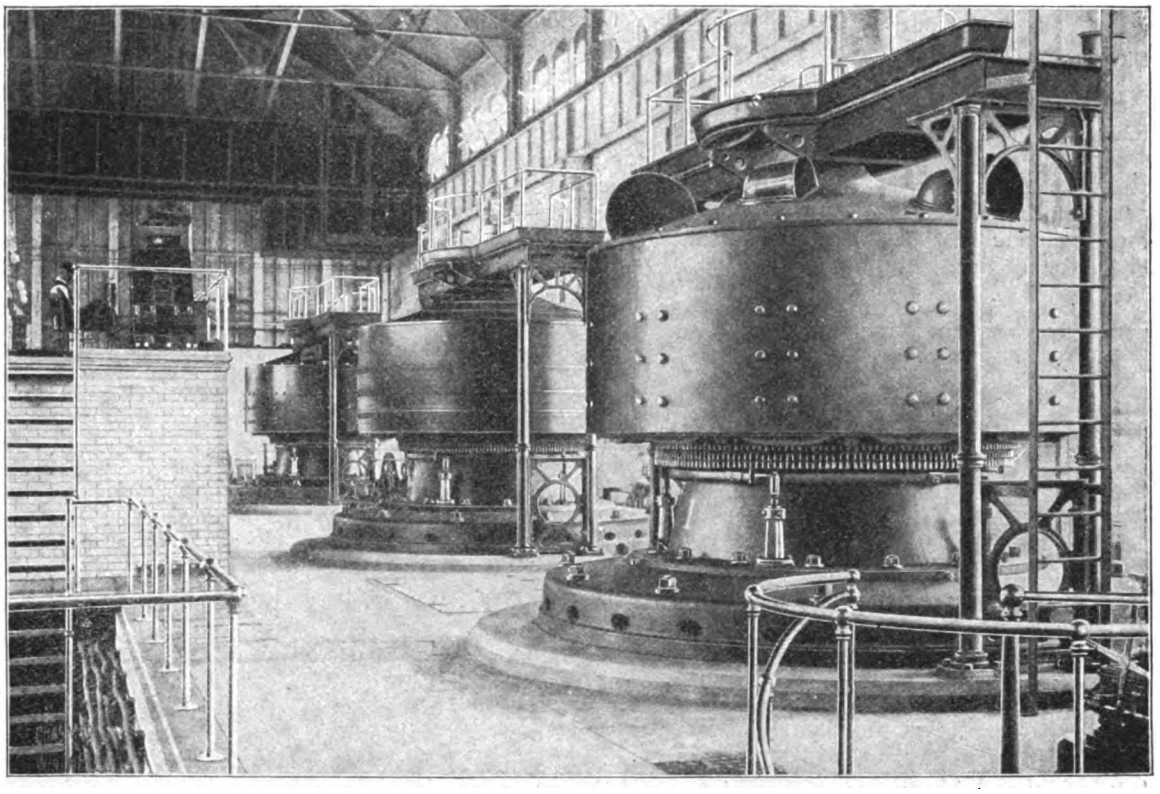
The Electrical Age.

VOL. XXII—NO. 17 NEW YORK, OCTOBER 22, 1898 WHOLE NO. 597

TRANSMISSION OF ELECTRICAL ENERGY.



Interior View of Power House, Niagara Falls. Power Generated by Westinghouse Apparatus.

TWO HUNDRED AND FIFTY THOUSAND HORSE-POWER TRANSMITTED BY POLYPHASE ELECTRIC CURRENTS.

To transmit and transform electrical energy is one of the greatest feats of modern electrical engineering. The erection of a transmission plant has made demands upon the constructing electrical engineer which require a comprehensive grasp of the factors involved and the circumstances and conditions under which the power is to be transmitted. A transmission plant, pure and simple, involves three indispensable elements: the generator, the line and, at the receiving end, the motor. It makes no difference whether the electricity is transmitted as a continuous or alternating current; in either case the engineer must stand ready to select apparatus best suited in design, pressure and nature of the current for transmitting the power. The more perfect the generator line, and motor, the greater the efficiency of the system. But judging merely from the high qualities of these three elements the question still remains open as to which is the best system for transmitting electrical energy.

The sources of natural power at our command are coal, wind and water. Thus far but few transmission plants have been erected whose sole dependence upon power could be found in the coal heap, and fewer still relying upon the variable force of the wind. But the number of electric transmission plants whose source of power is water may be numbered in hundreds; the greatest in the world to be found at Niagara. It is quite natural for those desiring to invest in electric light or power transmission plants to inquire into the various electric systems in vogue.

Practice in this country has been entirely directed toward the adoption of the cheapest, most elastic, and most desirable system to be found. The inventions of Nikola Tesla have given such impetus to the use of polyphase electric currents that today the largest transmission plants erected make use of polyphase currents and polyphase machinery. The advantages gained by the use of polyphase apparatus are such that simpler machinery is employed, less copper wire in the line, and a comparatively inexpensive receiving and distributing station. The fact that the pressure may be raised to thousands of volts and inexpensively transformed down to commercial pressures, makes a polyphase system of transmission superior to any other.

Dr. A. E. Kennelly, in an article entitled "The Present Status of Electrical Engineering in the United States," states as follows: "The principal engineering value of electricity today lies in its adaptation to the transmission of power through mills or cities, or from some locality where power is cheap to others where it is dear. A steel rope, by its bodily motion, can transmit with appreciable friction and depreciation some hundreds of kilowatts to a distance of from thousands of feet. A bare quiescent copper wire, one-half inch in diameter and supported on poles can, by maintaining an effective potential of ten thousand volts, by the motion of electric waves over its surface, transmit say twenty-five hundred kilowatts with an energy loss of two-thirds per cent. per mile and with practically no depreciation except that of the poles and support. The use of high pressures has thus become more frequent during the past few years. Alternating-current generators are now made to supply ten thousand volts at their terminals and insulation testing sets have been made for producing alternating pressures up to one hundred thousand volts effective. The electric transmission of the power of falling water is a branch of engineering that has come into service since

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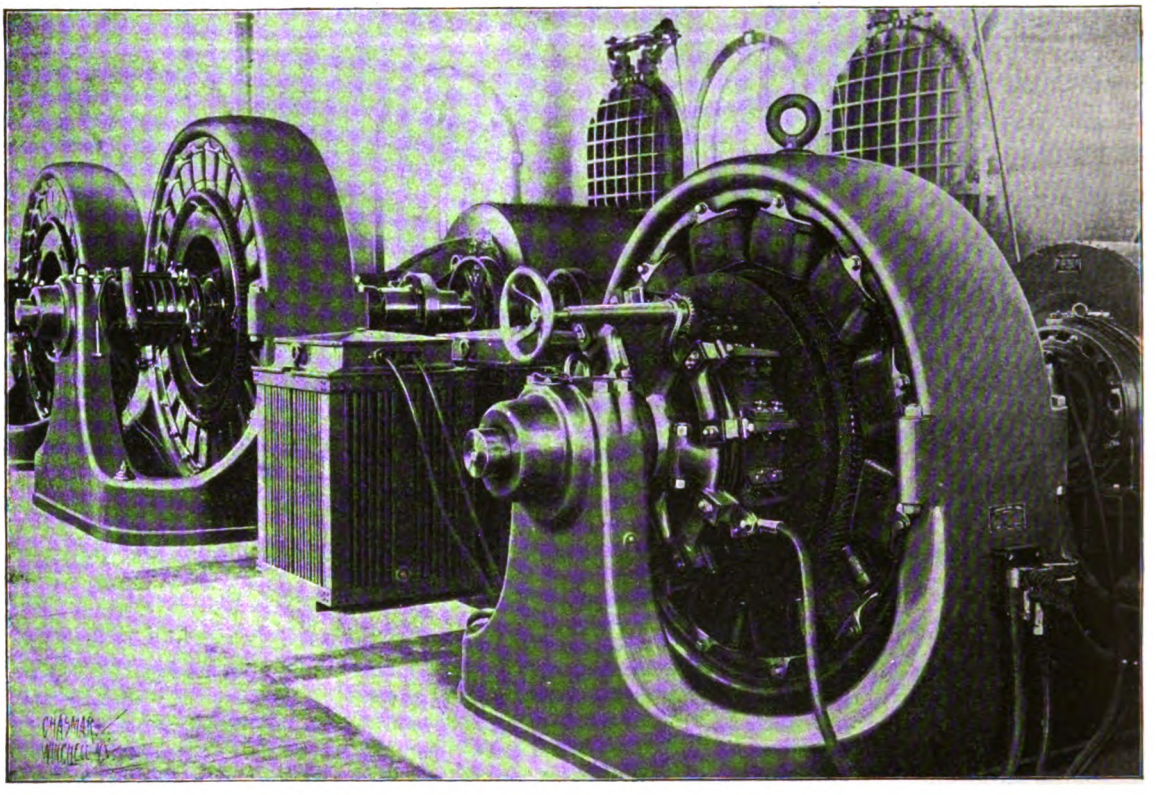
1884 and is making rapid strides owing to the recent successful employment of high voltages and multiphase alternating currents. It has been estimated that about one hundred and fifty thousand kilowatts of this class of machinery is installed on the North American continent, commercially transmitting power to various distances up to eighty-five miles at various pressures up to thirty thousand volts. The alternating-current induction motor has become very popular in recent years mainly owing to its powerful starting torque and its freedom from commutator and brushes. A burned-out armature, the perpetual source of dread in motor operations of days gone by, is practically unknown in this type of machine, even when put to severe service. Indeed, its depreciation under fair conditions appears to be as low as in any class of rotating machinery. The alternating-current transformer has been correspondingly improved, developing in large sizes and efficiency of about 98½ per cent., and an output when cooled by external power of about one hundred watts per pound of weight."

Aggregate horse-power of generators	219,649
Aggregate horse-power of motors and rotary transformers	35,511
Aggregate horse-power of static transformers	51,598
Total horse-power	306,758

The Westinghouse Electric and Manufacturing Company have sent polyphase machinery to every state in the Union; also, Brazil, Canada, Central America, England, Hawaiian Islands, Ireland, Jamaica and Mexico. In this Mexican plant at Tlalnepantla, bought by G. & O. Braniff & Co., a pressure of twenty-two thousand volts is used for transmission, the capacity of the plant equaling six thousand horse-power. The static transformers they employ, self-cooling and oil-insulated, have an aggregate capacity of seven thousand two hundred horse power.



Interior View of Power House at Dolgeville, New York.

The electrical power transmitted from Niagara Falls is generated by Westinghouse apparatus. The system in use is the polyphase; current is transmitted as far as Buffalo, where it is received in transformers and subsequently operates Tesla motors. About forty thousand horse-power used in this locality is consumed for industrial and manufacturing purposes on the American side. One thousand horse-power will soon be utilized when the transmission plant is complete on the Canadian side.

In the illustrations the Niagara Falls plant is shown—a scene familiar to most of our readers. Other illustrations show the machinery built by the Westinghouse Electric and Manufacturing Company of Pittsburg, Pa., for electric power concerns. The three-phase transmission system has been generally adopted by such concerns as the Helena Water and Electric Power Company of Helena, Montana; The Canadian Niagara Power Company of Niagara; The Apple River Power Company of New Richmond; The Niagara Electric Light and Power Company and many others. In total the list of polyphase-current transmission plants and equipments amounts to the following:

Lord Kelvin, formerly Sir William Thomson, one of the layers of the first Atlantic Cable, with Cyrus Field, while on a visit to this country in September, 1897, stated, "I believe that with proper apparatus electric current can be carried as far as three hundred miles from the place of its generation and be used with commercial success." This statement was made after he had seen the great five thousand horse-power Westinghouse generators at Niagara.

To transmit power from Niagara Falls to New York is an immediate and practical possibility. If it were not for the æsthetic taste of Americans the power of the great Falls could be used to run the machinery of Buffalo, Rochester, Syracuse, Albany and New York and illuminate their streets at night. The transportation of coal from the Pennsylvania fields to this city would be reduced to a minimum by the erection of a gigantic plant at the coal mines and the economical transmission of electrical energy from that point to Greater New York. Electric power would then be within the means of the poor as well as the rich to light and heat their homes and be the animating force operating the wheels of all industries.

Winchester, Va.—The Winchester Gas Co. contemplates installing an incandescent electric lighting plant.

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A FRENCH VIEW OF ELECTRICAL POWER TRANSMISSION.

(Continued.)

The price of the engine seems high; the present writer would be glad to sell first-class steam engine power at little over half the above figure.

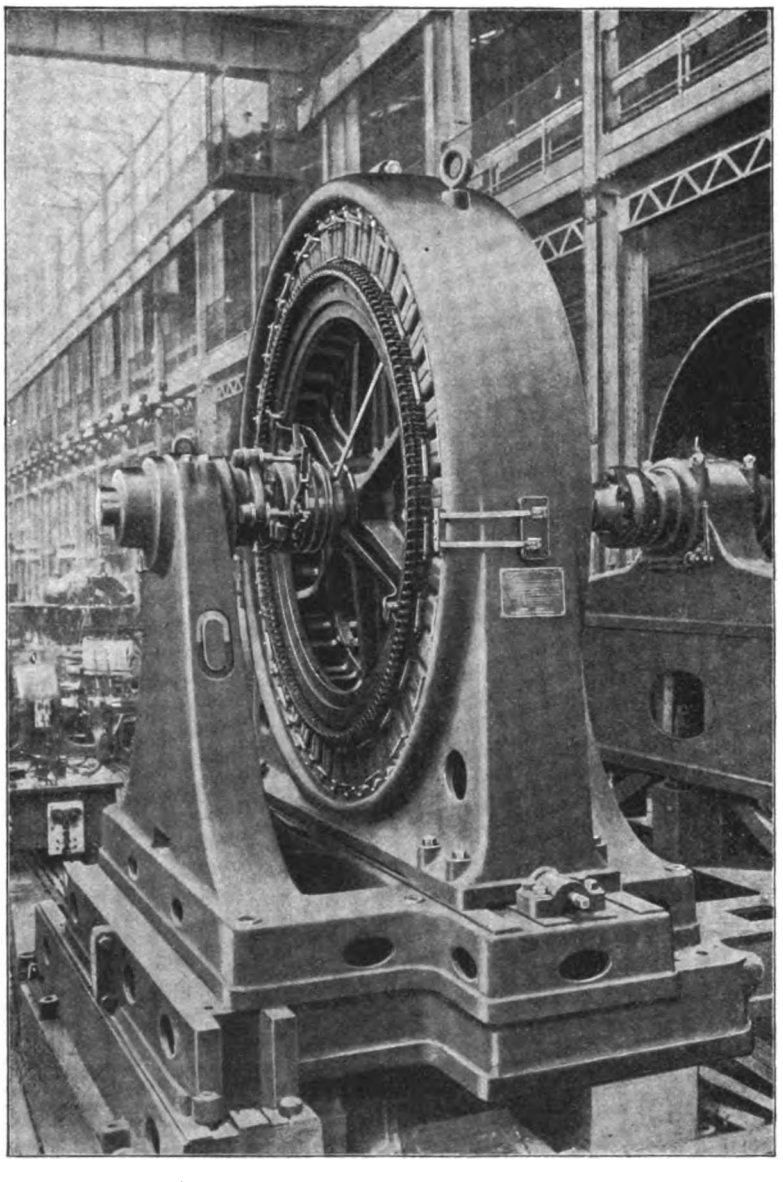
For a 300 H. P. engine the cost is thus set down:

Engine.....	£2,000
Boiler, etc.....	2,000
Buildings, etc...	800
Total.....	£4,800, or £16 per H. P.

while, for short working hours, steam may sometimes be better placed. The figures seem to us to indicate that the French are better hydraulic than steam engineers, and able to do more with a given sum than when they set out to instal steam plant. To pay £6,000 for boilers to give 1,000 H. P. in economical engines seems to us very high pricing.

Taking the case of 140 H. P. at the point of application, a hypothetical case is supposed at 4,000 volts, the water power being of the high-fall type, and the utilization day and night for 8,760 hours. The cost will then be:

For electric installation.....	£1,791
Hydraulic plant, 200 H. P. at 170 francs.....	1,360
Total.....	£3,151



650 Kilowatt, Two-phase Westinghouse Generator. Built for the Helena Water and Electric Power Co., Helena, Montana.

while a third estimate for 1,000 H. P. is:

Engine.....	£4,000
Boiler, etc.....	6,000
Buildings.....	2,000
Total.....	£12,000, or £12 per H. P.

Even at half the foregoing estimates the cost of steam plant appears higher than the cost of high fall water power, in addition to which there is also to be added the continual expense in fuel, wages, etc., and if the power is used for many hours, water power has the advantage,

Interest, etc., at 10 per cent	315

This is the annual cost. The same power from steam is given as follows:

140 H. P. at £20.....	£2,800
Interest at 10 per cent.....	£280
Total H. P. hours.....	1,226,400
Tons of coal burned.....	1,230
Cost at 30 francs per ton.....	£1,476
Total annual cost.....	£1,756

The coal is dear at 30 francs (24s.), and this item might be reduced anywhere down to a fifth, and the total cost would then be about £580, but even this is far above the cost of water power.

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Taking the voltage at 1,000 and a low fall and a utilization of 3,000 hours annually, the annual charge of 10 per cent. on the installation for the same power at the rate of £30 per H. P. will come out as £1,273, while the cost of the steam power will be as before, £280, for interest, and only £504 for coal, or £784 annually. Even with such dear fuel, the steam now comes very much cheaper than water power. It is thus important to seek high falls, high tensions, dear coal, and long hours in a proposed water power with electrical transmission, while the reverse data favor the application of steam power.

The figures presented by M. Janet are by no means favorably chosen for steam power. It is obvious, therefore, that coal-using countries are not likely to be so easily run off the road as loose thinkers are so apt to make out.

In discussing the system of transmission to be employed, there is but one alternative; direct or alternating currents alone are available; the first-named have the advantage of age, having been those of the Gramme machine. A dynamo may be constructed for all speeds, tensions, intensities, and other properties, so long as these are properly balanced; but for continuous-current machines there remains the difficulty of insulation at high tensions. This difficulty comes in at the commutator. This becomes so multiple in its bars at high tension that difficulties arise in construction. Without going into details, it may be said that currents of 3,000 to 4,000 volts work all right, and they may be coupled so as to add to this tension, and partisans of continuous current are still numerous, despite the brilliant success of alternating current, and would not hesitate at continuous transmission even at 20,000 volts. But the author believes that the current of today is the alternating. Simpler machines produce it; the commutator is absent. Transformers are applicable for raising the tension to any desired amount—apparatus without a moving part.

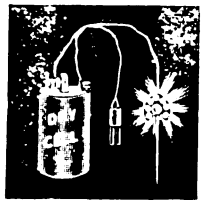
With all advantages, however, the alternating current has also its disadvantages. While the motors are also simplified, they present difficulties in starting not yet surmounted. Though very well for regular work at full power with few stoppages, the alternating current must still give way to direct current for opposite conditions. This difficulty, however, appears likely to be swept away by the discovery of the polyphase alternating machines. Equally available for high tension, they have the general advantages of continuous currents, and in respect of starting of motors are but little in arrear of the latter. They have the further advantage of diminishing the weight of line necessary. Without going into detail, it may be said that tri-phase machines have three terminals in place of the two we are accustomed to find in all electrical appliances—three lines in place of two.

Thus, if E be the tension between any two terminals, I the current in the line, it can be shown that the power carried under these conditions is $P = E I \sqrt{3}$. If R is the resistance of one line, the power lost in the line is $3 R I^2$. With two-line transmission to carry the same power at equal tension, $P = E I'$ where $I' = I \sqrt{3}$. Let R' be the resistance of one of the two lines, then the power lost will be $2 R' I'^2 = 6 R' I^2$. If we desire the loss in each case to be the same, then must $3 R I^2 = 6 R' I^2$, whence $R = 2 R'$, from which it directly follows that with tri phase current the cross-section of each line will be of half the area needed for ordinary current. If p is the weight of one line of tri-phase the total weight of line for tri-phase current is $3p$, and for ordinary current $4p$, thus securing an economy of 25 per cent.

All this demands that the introduction of polyphase current should be considered as one of the greatest steps in modern electrical industry—and, in fact, most large installations are based on polyphase working. Yet continuous current will never lose its advantages, and will always be used for certain special cases, but it seems that simple alternating current ought to be excluded from new installations. This has been a little forgotten of late.

The author concludes that the exhibition of 1900 will afford a chance of studying all systems on a grand scale. We should add that the author of the interesting article we have abstracted as above is M. Paul Janet, of l'Ecole Superieure d'Electricité.

The above interesting and exceedingly instructive article was translated by a contemporary, the London "Electrical Review," from the French. By the use of polyphase currents, the advantages gained in a commercial and financial sense are very great. Both practice and theory bear out this idea. M. Deprez was among the first to attempt electrical transmission of energy; his countryman, M. Paul Janet, is a worthy disciple.



WILLIAM ROCHE of 259 Greenwich street, N. Y., has just placed on the market a new No. 4 vest-pocket battery that will light a small incandescent lamp. For novelties, scarf-pins, etc., it will give on closed circuit 1 6-10 volts and nearly 11 amperes. One of these cells measures 3 1-2 inches high, 1 5-8 inches in breadth, and 1 1-16 inches in width, oval shape.

These combination vest-pocket batteries are very valuable and have been adopted in laboratories for testing, etc. Mr. Roche's 7-inch x 3-inch cell has been adopted by physicians for cautery work, and he can refer to a number of physicians using this cell who will testify to its being the only dry cell used for practical cautery work.

The demand for Mr. Roche's No. 1 and 2 dry cells is increasing to such a great extent that he intends taking an entire building to make up stock, so as to keep pace with the large demand for his goods, as every mail brings in new orders.

The fact that the United States Navy adopted the new Standard dry batteries for every need in their department is sufficient guarantee as to their quality.

We desire to call particular attention to Mr. Roche's new 7-inch x 3-inch cell for gas engine, slot or automatic machine work.

STRAY CURRENTS.

An exchange notes that the Canadian Pacific Railway Company has one through wire on its telegraph line from Montreal to Vancouver entirely of copper. The length of this wire is 2,897 miles.

Professor Zickler, of Brunn, has invented a system of wave telegraphy which depends upon the fact that if the ultra-violet rays of the spectrum are directed upon a spark-gap, the latter may be wider than it otherwise could be and yet allow the spark to pass.—Ex.

Regarding the amount of electrolytic action of brass pipe in comparison with other materials, such as iron, copper or lead, there appear to be no positive data. A study of the chemical equivalents of the various metals used in underground construction will, however, indicate that common brass pipe, containing about 70 per cent. of copper and 30 per cent. of zinc, would suffer from electrolysis somewhat more than iron pipe and not so much as lead. Approximately, a current of one ampere flowing steadily from an iron plate of ample proportions will remove about 20 pounds of iron per year. Under the same conditions 75 pounds of lead could be removed, and brass would suffer a loss somewhere between these figures.—Ex.

M. H. Le Chatelier has presented to the Academie des Sciences a series of valuable observations on the effect of temper and constitution upon the electrical conductivity

(Continued on page 232.)

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A PHYSICAL LABORATORY FOR THE PEOPLE.

We have commented in previous issues of "The Electrical Age" upon the great advantages resulting from the founding of a national physical laboratory. It seems that in England they have seriously considered the advantages of such an institution, and a committee composed of Lord Raleigh, Sir Courtenay Boyle, Sir Andrew Noble, Sir John Wolfe-Barry and Messrs. A. W. Riecker, W. C. Roberts-Austen, Alexander Siemens, T. E. Thorpe and Robert Chalmers has been appointed to consider the proposition from two standpoints. We are content with considering these standpoints and the conclusions arrived at by the committee.

As this matter has become, in a sense, of immediate national consequence under direct government control, it will certainly be interesting to Americans to read the following:

"The desirability of establishing a laboratory for the verification of instruments, testing materials, and maintaining standards is the first question. The second is in relation to the desirability of associating this laboratory with any public institution." The replies turned in, according to our esteemed contemporary, "The London Electrical Review," are as follows: First. That a public institution should be founded for standardizing and verifying instruments, for testing materials and for the determination of physical constants.

Second. That the institution should be established by extending the Kew Observatory, and that the scheme should include the improvement of the existing buildings and the erection of others in its neighborhood.

Third. That the Royal Society should be invited to control the proposed institution and to nominate a governing body on which commercial interests should be represented; the choice of the members of such body not being confined to fellows of the society.

Fourth. That the permanent secretary of the Board of Trade should be an ex-officio member of the governing body; and that such body should be consulted by the standard office and the electrical standardizing department of the Board of Trade upon difficult questions that may arise from time to time or as to proposed modifications and developments.

Whereas the tone of this entire series of conclusions is peculiarly English, it is as English thoroughly businesslike, on account of the fact that the Royal Society exercises direct control over this institntion. There is another feature of supreme importance to ourselves in this circumstance, and from it springs a lesson that will day by day become more apparent, that the knitting together of the interests of the nation and our savants is productive of the highest good and greatest benefit to the general public. The field of scientific development has grown and is growing to such enormous proportions that this coalition is natural and in perfect harmony with our ideas of progress. Applied science has added so much to the wealth and prosperity of the United States that the establishment on our part of a great national laboratory would give great impetus to fields of work still inchoate and new life to the efforts of worthy and practical inventors.

ELECTRICIANS MEET FOR SOCIAL PURPOSES.

The representatives of leading electrical industries of the Eastern States met Tuesday evening, October 25th, with their wives and friends at Wallack's Theatre, where seats had been secured in advance for the "Fortune Teller." It is the idea of certain active spirits that the formation of a new association, attendance to which will mean pleasure for the ladies as well as the gentlemen, will meet with great success among the representatives of our Eastern concerns. By bringing together families and friends in the trade, certain great benefits are derived which offer a solution to some of *our* most serious commercial problems.

In consequence of invitations sent out to those connected with the electrical industry, a very large number accepted, and nearly a hundred gentlemen, with their wives and fair friends, spent part of the evening listening to the Alice Neilson Opera Company. The guests were received by a committee composed of H. B. Kirkland, John Dale, Frank Harrington, E. S. Keefer and H. Baker, respectively of the following concerns: the American Circular Loom Company, Dale Manufacturing Company, India Rubber & Gutta Percha Insulating Company, Western Electric Company and the Elektron Manufacturing Company.

During the opera Mr. Dale presented a startling and beautiful bouquet of roses to Miss Neilson. Just before she accepted the bouquet Mr. Dale touched a button which caused it to throw out a blaze of electric light. The bouquet had been made up with ingeniously hidden batteries operating a number of miniature lamps. Miss Neilson was greatly amazed when the light was thrown on. The applause was deafening. She was encored three times and finally came before the curtain, an unusual proceeding on her part.

After the opera the party took electric cabs to the Astoria, where a fine collation awaited them. Each of the members of the committee attended to one of the five tables and introduced the guests to each other. Each lady received a beautiful bouquet of chrysanthemums, roses and other flowers, and the gentlemen a boutonniere. The menu cards were a great novelty, and were all kept in remembrance of the occasion.

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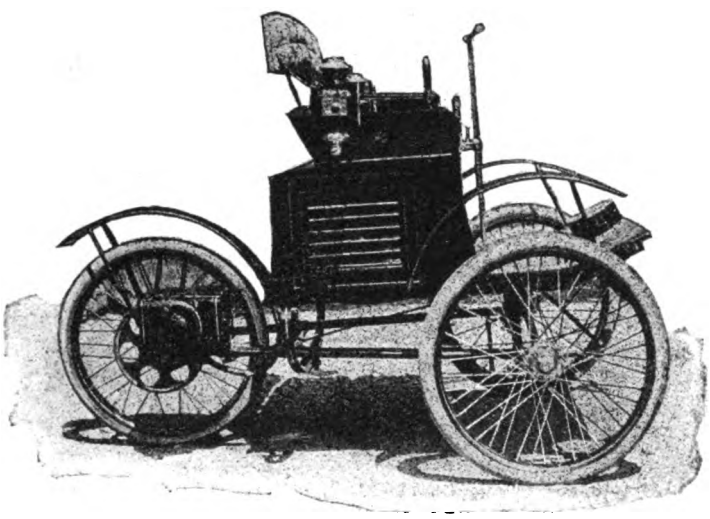
of steel. The most important experiments were directed to ascertain the influence of the temperature of tempering upon the conductivity, samples of steel containing 0.84 and 1.13 per cent. of carbon being chosen. The subjoined table shows the ratio of the resistance after tempering to that before tempering, the temperatures being given in the top line:

Temperatures.....	——————Degrees——————					
(Centigrade).....	710	740	810	850	950	1,000
0.80 per cent. carbon.....	1	1.3	2.1	2.2	....	2.2
1.13 per cent. carbon.....	1	1.3	1.6	2.1	3	....

These results go to show that tempering does not modify the resistance if performed at temperatures below the point of recalescence (710 degrees C.), the same condition holding good for the change in mechanical properties. The resistance then increases with the temperature of tempering up to a maximum depending upon the carbon content of the steel, the higher carbon steels going up to higher resistances. The presence of chromium in the steel causes the increase of resistance to become more marked, while tungsten seems to exert a contrary influence.—Ex.



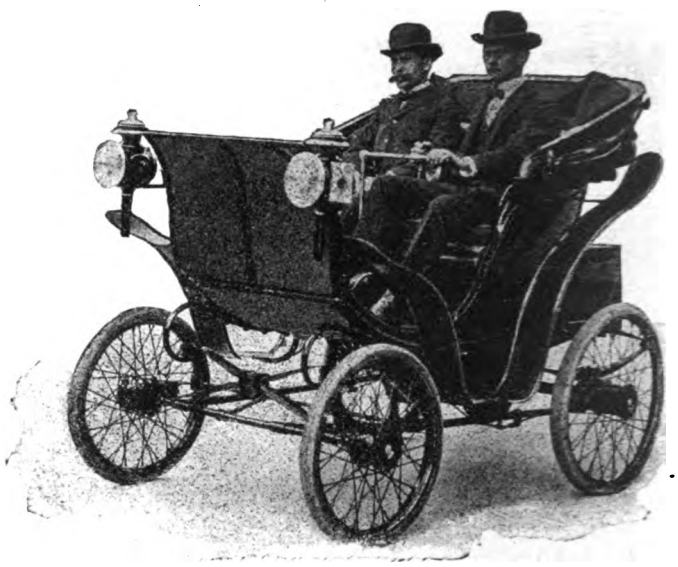
Riker Electric Tricycle.

ELECTRIC AUTOMOBILES.

ELECTRIC MOTOR VEHICLES.

The illustrations accompanying this sketch show a variety of electric motor vehicles, the use of which will, in the course of time, become so general that Greater New York, Paris and London, as well as other large European cities, will present the same appearance in regard to the method of street locomotion in vogue. The ideal vehicle is acknowledged to be one driven by electricity. For summer service there is nothing that can bear any comparison with the electric auto-mobile, and in winter during evening the well-lighted interior of these carriages, noiseless advance, cleanliness and freedom from motion speak for themselves. The steady increase in the number in use proves to the casual observer that the electric vehicle is fast becoming a feature of city life as familiar to him as electric cars and other modern conveniences.

The Riker Electric Motor Company manufacture an electric tricycle with tires two and one-half by twenty-eight inches in diameter. Its weight without load is eight hundred pounds and its carrying capacity four hundred and fifty pounds. The tricycle is run by a three-quarter K. W. motor, governed by a controller giving three speeds ahead and two behind. This tricycle can cover twenty miles per charge of battery on level roads. Its maximum speed is twelve miles an hour. It is supplied with a combination voltmeter and ammeter, electric side lights, and is driven from the rear and steered from the front wheels.



Riker Electric Victoria.

The Riker victoria has tires three by thirty-two inches in the front and thirty-six inches in diameter at the rear. Its weight is eighteen hundred pounds, seating capacity two people, and is operated by a one and one-half K. W. motor, governed by a controller giving three speeds forward and two speeds backward. The total mileage per charge of batteries on level asphalt and mac adam reaches twenty-five, the maximum speed practicable twelve miles an hour. In other respects the general construction of the Riker electric auto-mobiles is similar, the phæton holding two passengers, weighing eighteen hundred and eighty pounds, and being driven by a one and one-half K. W. motor; the two-passenger trap weighing sixteen hundred pounds, same horse power of motor; the four-passenger trap weighing twenty-five hundred pounds and being driven by a two K. W. motor.

Mr. Riker's delivery wagon, one of the most beautiful constructed, made for the firm of B. Altman & Company,

Riker Electric Phæton.

weighs twenty-nine hundred pounds. It has a carrying capacity of eight hundred pounds, in addition to the operator and delivery man, and is driven by a three K. W. motor. Its maximum speed is nine miles an hour, and it can cover twenty miles on level roads for each charge of battery.

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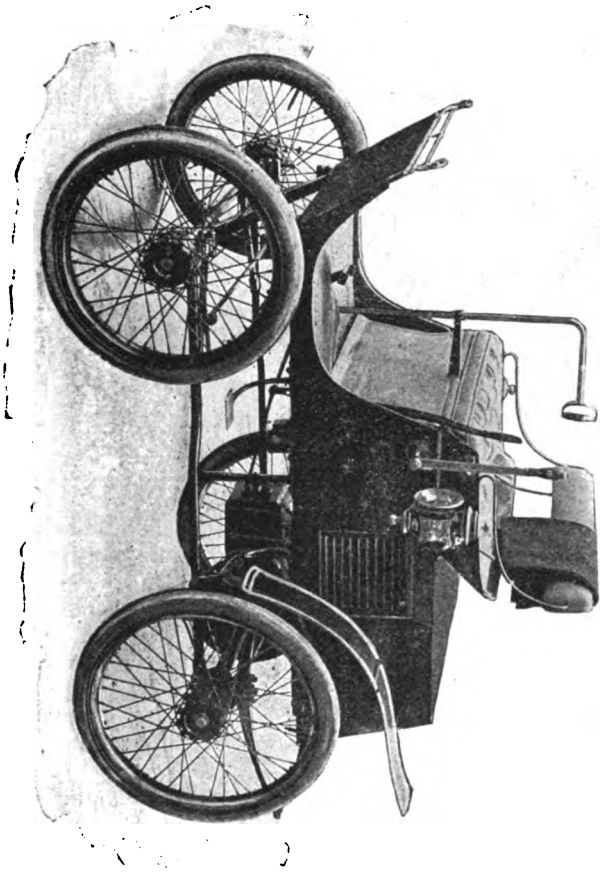
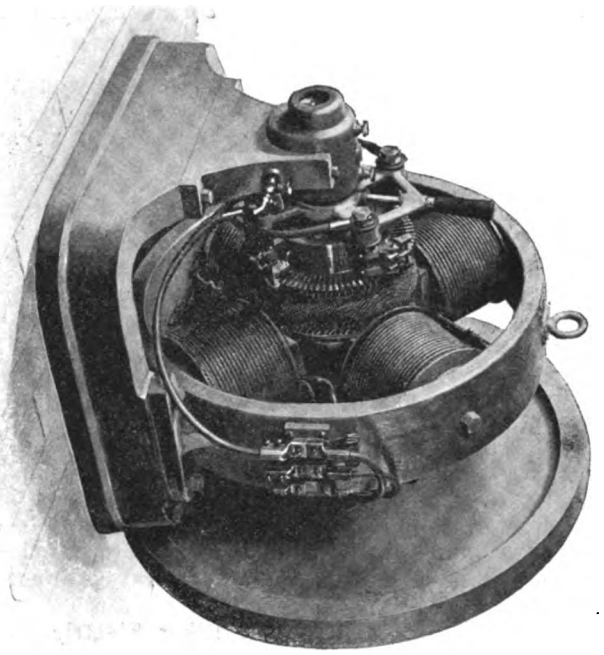
With the exception of the electric tricycle the carriages above described can cover a run of twenty-five miles without recharging, including the four passenger trap.

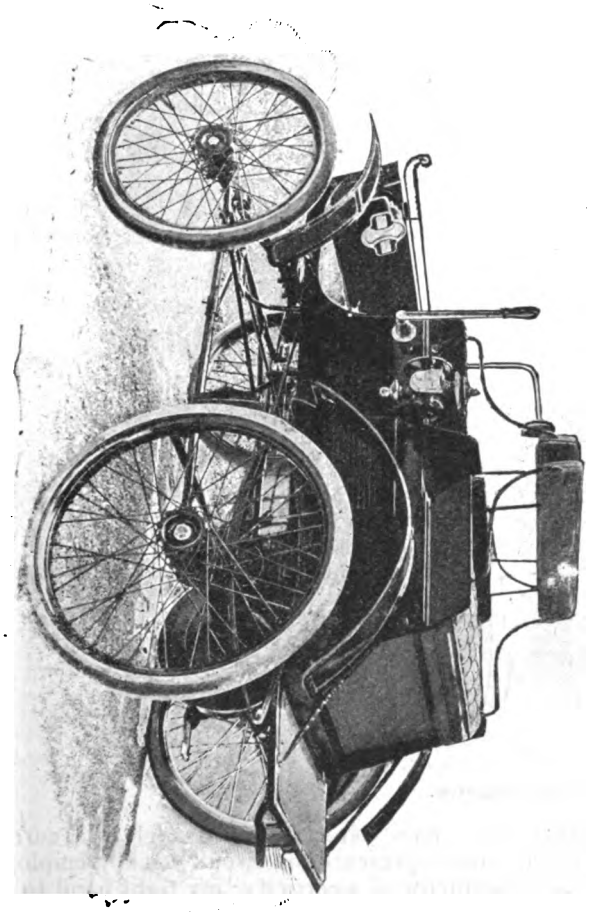
ure in showing our readers the Riker electric vehicle motor, with cover removed, showing commutator. They are made in sizes running as follows: three-quarters, one



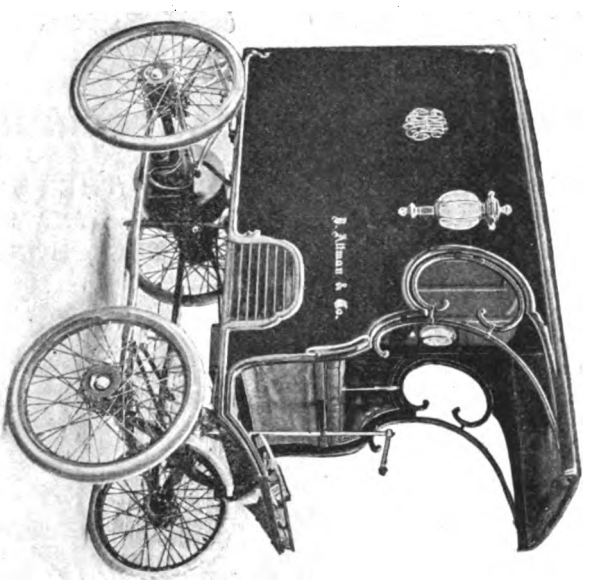
Riker Electric Two Passenger Trap.



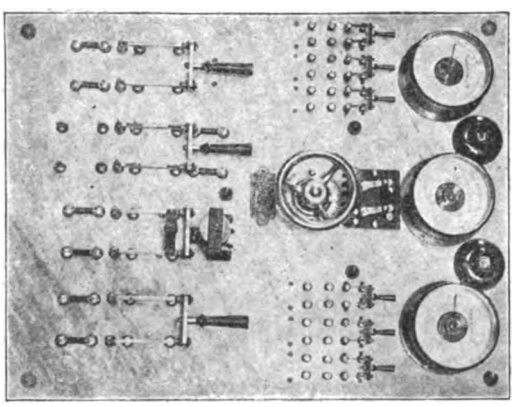
Riker Fly Wheel Dynamo for Belt Connection to Gas Engine.



Riker Electric Four Passenger Trap.



Riker Electric Delivery Wagon.



Switch Board.

This delivery wagon is supplied with a combination volt and ammeter, electric side lights, driving from rear wheels and steering from front wheels as those previously described. In addition to these illustrations we take pleas-

and one-half, two and three k.w.; the larger sizes take eighty volts, the three-quarter k.w., forty volts. The weights respectively are, eighty, one hundred and sixty, one hundred and seventy-five and two hundred and

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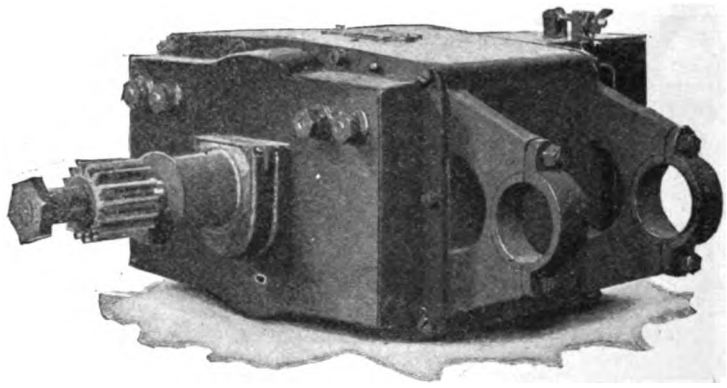
eighty-five pounds. An interesting addition to the apparatus required for electric motor vehicles is the Riker fly-wheel dynamo for belt connection to gas engines. It is not subject to fluctuations in speed of the engine and gives the greatest satisfaction in charging the storage cells. The switchboard, supplied with a complete charging plant, is also represented. For compactness, high efficiency, durability and convenience, the fly-wheel generator, switchboard for charging one or more vehicles at the same time and electric carriage apparatus cannot be excelled.



Riker Electric Vehicle Motor.

The factory and offices of the Riker Electric Motor Company are at 45–47 York street, Brooklyn, N. Y.

Under the heading of Opinions of Experts, Mr. Kennelly's article will be continued next issue.

AMONG OUR ELECTRICAL FREINDS.

AN ORIGINAL DEMONSTRATION OF THE FUNDAMENTAL PRINCIPLES OF THE DYNAMO, THE TELEGRAPH AND THE TELEPHONE.

By C. J. Miller.

'Twas Willie Crinkle's first opportunity, and he embraced it bravely. Just a year out of college, but it shows the genius of the lad. While almost everyone else around the festive board had had his little say upon some topic or other in the technical field of applied science, Willie was still to be heard from. Electricity had been his study, and he had not yet spoken. It was soon to be his turn, and he was quietly fathoming every nook and corner of his inexperienced young mind, aware that as soon as the present speaker finished he would be called upon to dilate upon the subject of electricity. His neighbor had just sat down amid the shouts and applause of his colleagues.

"Mr. Crinkle," came the voice of the toastmaster, and in the way of an introduction presented him by saying:

"Now we'll have some electricity. To be brief, here is a topic none of you have touched upon, perhaps out of respect to Mr. Crinkle's presence. We, no doubt, have the treat of the evening in store for us, probably in the shape of a thunderbolt from our friend Crinkle. As Vulcan, we will listen to him with all the reverence required by so mighty a deity."

Mr. Crinkle, arising in a half-hearted manner, very much embarrassed at first, soon became eloquent. He said:

"Gentlemen, since electricity is the subject with which I am most familiar, I feel it my duty, as everyone else has contributed to my entertainment, that I should at least try to do the same in return. I, however, promise you no entertainment unless it be a charitable interpretation of my efforts by yourselves. To begin with, I have thought out a simple plan of illustrating, in a few words, the principle of the telegraph, the telephone and the dynamo. Under these very peculiar circumstances, I shall have to employ all of you to help me a little in illustrating what I have in mind.

"In the first place, since there can be no flow of electricity without a closed circuit, I will ask you all to join hands. This chain has passing through it a current of good will, and represents the circuit usually employed to act as a conductor of electricity; my right hand to represent the positive pole and my fair neighbor's the negative. The good food and wine I have partaken of we will suppose to represent the chemical constituents of a rather strong cell. The current will flow from my right hand around through your bodies to my left.

Opening Remarks of the Demonstrator.

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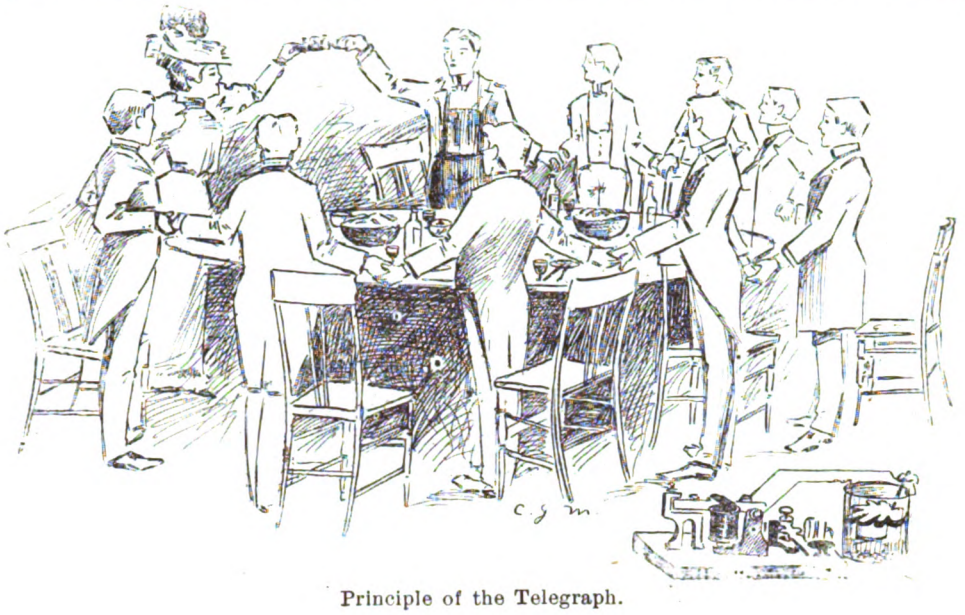
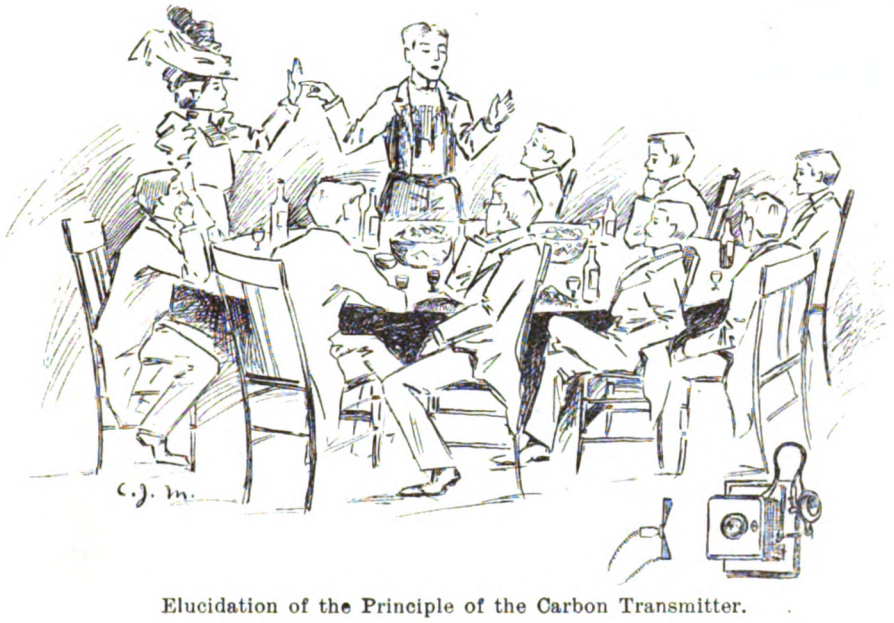
"To illustrate the telegraph, which is merely a combination of an electric circuit, battery, key and sounder, I will proceed as follows; this little pocket outfit I possess



Principle of the Telegraph.



Elucidation of the Principle of the Carbon Transmitter.

Rotation in a Magnetic Field.

serving me in many cases when I have an odd hour to practice with. Should I, as battery, be too strong it will be easy for my neighbors to offer resistance to me. On the other hand," said Mr. Crinkle, smiling upon his auditors, "a display of weakness on my part can be quickly remedied by the addition of a small bottle of exciting fluid. If you will notice, the movement of the key would, in the light of my remarks, open and close the circuit and operate the sounder, exactly as it is performed in actual

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practice. By exercising your imaginations in my behalf you will now comprehend the action of the carbon button transmitter; my fair neighbor's palm the diaphragm, my finger the carbon block, through the variability of whose touch are transmitted sound waves, transformed by this mechanism into unequal flows of current.

"It is hard, at first, to understand how a dynamo generates electricity, but if we bear in mind Faraday's great discovery, that a closed coil revolving in a magnetic field will develop a current of electricity, it will be easy to understand my ocular demonstration. Let each alternate man around the table take both hands of his neighbor, so as to form a succession of separate loops. These are the independent coils of an armature, or a motor, if you will have it so. By closing the circuit and providing a magnetic field, the coils are set in rotation, or conversely, if rotated before myself and partner, will produce a series of electric currents. In other words, the fundamental principle of the dynamo is illustrated by pairs of you clasping hands and moving quickly in continued rotation around the festive board.

"I hope that if the instruction you have derived from my extemporaneous remarks has not been wholly satisfactory, you will at least have been entertained and interested sufficiently to allow me to resign my position in favor of our worthy toastmaster."

ELECTRIC LIGHT AND POWER.

POSITIVE AND NEGATIVE ECONOMIES IN THE OPERATION OF SMALL ELECTRIC LIGHT PLANTS.*

(Continued.)

A bicyclist knows the advantage of a light running, well lubricated wheel, but often that same bicyclist will vote against spending money to save power in an engine. It is sometimes said that a woman's idea of a horse power is only limited by the number of people who can get into the vehicle. There have been, in the past, men who held similar ideas as to the horse power of an engine—"as long as the horse can do it, all right"—the same as to the engine.

The Engine.

We now come to the engine: In large stations it is customary to so operate that whenever an engine is in use, it is at or near its rated load or point of maximum economy of operation. Most engineers know that to run an engine on a light load is wasteful, but many do not realize that it is one of the greatest of extravagances. The losses in an engine are very nearly constant, and therefore for light loads become a very large percentage of the total. Suppose we have a 200 horse power engine in use eight hours nightly, on a load which a 75 horse power engine would run at a rated load. If the engines were of the same type there would be practically no difference for these sizes in the amount of steam per indicated horse power. If we take an automatic non-condensing engine, giving one indicated horse power for twenty-eight pounds of steam, we would have per brake horse power:

For 200 h. p. engine at 75 i. h. p.—53 lbs. per b. h. p.
For 75 h. p. engine at 75 i. h. p.—33 lbs. per b. h. p.
Difference—20 lbs. per b. h. p.
20 (lbs.) × 67.5 (h. p.) × 8(hrs.) × 365 (days) = 3,942,000.

If evaporating seven pounds water per pound of coal this gives 563,143 pounds, equals 281.57 tons. This at $1.50 a ton equals $422.35. In small stations, an evaporation of only five or six is often the average result, and the above amount would be proportionately increased. If we install a 75-horse power engine to take this light load after the heavy load has gone off there would be no additional depreciation or repairs, because of having the additional engine; in fact, the total may be less, because there would be more time to adjust each engine. The engine, including foundation, would cost probably $1,000 to $1,300—extra piping and building (if necessary) possibly $700; call this a total of $2,000. The only additional fixed charges would be:

Interest on $2,000 at 6 per cent	$120
Depreciation on $700 at 6 per cent	42
A total of	$162

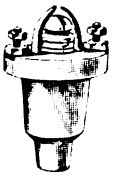
(and part of this is questionable), leaving a balance of $260.35, equal to a trifle over 16 per cent. profit, additional to the 6 per cent. already allowed, besides obtaining a more reliable plant.

The Load and the Boiler.

In the majority of small plants, the engine, or engines, run for many hours at a very light load. Whether or not the addition of a small engine coupled to the same dynamos, or to an additional and smaller dynamo, would pay, can only be ascertained by a special examination into all the factors in each case. In one case a change was made by the advice of the writer, in the shafting arrangement, and the entire cost, including an addition to the building, was repaid in a comparatively short time. It is often said, even by engine men, "Do not get your engine cylinder too large—only large enough for the maximum work it may be called upon to do, and do not get the other parts too small." This refers to an engine for a variable load. The best proportions for a constant load are different, especially if the engine is compound, as to the ratio of the cylinder diameters. In some cases too low steam pressure is carried, and in others it would pay to condense. It is often a fact that the valve and piston leak, and that the valves are not properly set. Such losses may readily amount to 25 per cent. of the steam consumption, and not be accompanied by heating or pounding. How much can be afforded to save 20 per cent. of the steam? Practically 16 per cent. to 18 per cent. of the cost of the coal, being a little less than the 20 per cent., because some coal is used for banking and starting fires. A station burning two tons per day at $1.50 per ton, or $1,095 annually, can afford $175.20, and even if this entire amount be spent, the engine will run better and with less depreciation.

(To Be Continued.)

NEW ELECTRIC GAS-LIGHTING BURNER.



The cut illustrates a new form of burner, or tip, to be employed in connection with series electric gas-lighting apparatus, otherwise improperly designated "multiple;" that is, a form of gas lighting in which a number of jets are to be ignited simultaneously, as employed in theatres, churches, etc. It presents a number of novelties. It is intended to be a substitute for the common lava tip in the ordinary pillar burner, or in what are known as candle burners, the base being arranged to fit the metal socket designed to receive and carry the common lava tip in either form of burners referred to. The novelty consists in the use of porcelain in the place of steatite or "lava," such as has been employed heretofore for such purposes.

It is claimed by the manufacturer that lava is a poor insulator where currents of high potential are employed, such as are produced by the frictional machine or Ruhmkorff coil, the usual generator in such cases. For this purpose porcelain has proven itself to possess far higher non-conducting characteristics and, further, is less liable to breakage, either through accidental blows or on ac-

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count of increased temperature due to the flame. This makes the new tip more durable and lasting. The top of the body is provided with grooves, in which the electrodes are placed, which prevent the latter from shifting from their proper position, and thus changing or increasing the length of spark gap for which they are originally set. Another new feature consists in the means of attaching the circuit wires to the electrodes. Heretofore this has been achieved by providing holes in the electrode, which projected beyond the body of the burner. In the improved form screws with movable nuts are supplied, constituting practical binding posts, by which a sure connection can be made with great simplicity and ease, as well as neatness.

This new tip is being put upon the market by the A. L. Bogart Company, of 123 Liberty street, New York City, who are making a specialty of this class of apparatus.

EDUCATIONAL.

ELECTRICAL INSTRUCTION BY MAIL IN NEW JERSEY.

A meeting of exchange managers, switchboard men, linemen, and other employees of the New York & New Jersey Telephone Company, from Newark, Jersey City, Paterson, Hoboken, Orange, Asbury Park, Morristown and other places in Northern New Jersey, was held on the evening of the 23d ult. at the office of the New York & New Jersey Company, No. 185 Market street, Newark, N. J., when The Electrical Engineer Institute of Correspondence Instruction, No. 120 Liberty street, N. Y., was represented.

Mr. Alfred J. Wolf, of Brooklyn, N. Y., delivered an address, describing the plans, purposes and methods of the Electrical Engineer Institute, for conveying instruction by correspondence in the various branches of electrical engineering, and was followed by Mr. Henry W. Livingston, chief representative of the Institute, who called additional attention to the educational facilities afforded and to the convenient terms of payment for courses of instruction which the Institute allows. Mr. Edward E. Winters, formerly superintendent of the New York Light, Heat and Power Company, was also present at the meeting on behalf on the Institute and aided Messrs. Wolf and Livingston at the close of the meeting in entering a large number of enrollments of students, chiefly for the special course in telephony.

The institute has been so much appreciated by the officers of the company mentioned that a series of technical lectures by eminent electricians is in contemplation, to be given during the coming winter in Brooklyn, Jersey City and Newark, to harmonize with and make additionally beneficial the Institute's lessons. The enrollment of employees in the courses of the Electrical Engineer Institute, aided by these lectures, is intended to take the place of a very complete night school system, which was, until somewhat recently, in contemplation by the officers of the company, but which has now been abandoned in favor of the preferable and more practicable plan of correspondence instruction, properly administered.

POSSIBLE INSTALLATIONS.

Kansas City, Mo.—A power house will be erected by the Missouri Electric Railway Company. Address F. W. Sears, general manager.

Orangeburg, S. C.—Arrangements to receive estimates for the proposed electric light plant and water works will be made shortly by the commissioners of public works. Forty thousand dollars were voted recently for this purpose. Address J. G. Wanamaker.

Jacksboro, Tex.—An electric light plant, ice factory and cold storage plant will shortly be erected. A company has been incorporated for this purpose, capitalized at $10,000.00; John Hensley, president, and J. E. Campbell, secretary-treasurer.

Fredericksburg, Va.—Plans and specifications for the city's proposed electric light plant are being prepared by D. F. Stokes, of Philadelphia.

Pine Bluff, Ark.—Walter S. Jeter can give information concerning erection of electric light plant.

New Orleans, La.—The Crescent City Electric Co. will erect a power station to be equipped with 1,000 kilowatts.

Monroe, La.—The Mayor may be addressed concerning proposed electric light plant.

Natchez, Miss.—The Natchez Gas Light Co. is extending its service.

Florence, Ala.—Frank M. Perry contemplates the establishment of an electric light and power plant in connection with several other enterprises now building.

Miami, Fla.—An electric light plant is to be established by Mr. Flagler.

Lawton, Mich.—City Clerk may be addressed concerning proposed establishment of electric light plant.

Gallatin, Tex.—City Clerk may give information concerning electric light plant.

Spartansburg, S. C.—The Ætna Light & Power Co., recently purchased by New York parties, will probably improve and enlarge its lighting plant and resume operations.

TELEPHONE CALLS.

New York, N. Y.—The People's Telephone Co. has been incorporated by S. B. Dutcher, J. E. Nichols, E. S. A. de Lima, Francis C. Travers, Frank Brainerd, J. Fred Ackerman, and Darwin S. James; to operate lines of telephone from this city to points within the United States and Canada. Capital stock, $5,000, of which $2,000,000 is to be preferred stock.

Little Rock, Ark —The American Telephone and Telegraph Co., recently incorporated, will construct a telephone line from Little Rock to Memphis, Tenn.

Hazen, Ark.—The Grand Prairie Telephone Co. has been incorporated by George D. Foster, J. G. Thweats, J. M. McClintock, A. L. Aydiet and David Brockway. Capital stock, $10,000.

Charleston, W. Va.—The National Automatic Telephone Co., principal office in Chicago, Ill., has been incorporated by John Anderson, E. W. Ober, W. W. Watson, C. A. Watson, L. A. Will, F. A. Lundquist and J. D. Milliken. Authorized capital, $1,000,000.

STREET RAILWAY NEWS.

San Francisco, Cal.—Electrical Railway and Manufacturing Supply Co. has been incorporated by Samuel H. Taylor, Frank Frisbee and Henry P. Howel. Capital stock, $50,000.

Kansas City, Mo.—The Missouri Electric Railway Co. will build a power house.

Cincinnati, O.—The Milford & Goshen Street Railway Co. has been incorporated by William A. Goodwin, M. C. Campton and otheas; to build and operate an electric railway in Hamilton and Clermont Counties. Capital stock, $10,000.

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NEW INCORPORATIONS.

Jersey City, N. J.—The Insulated Wire Co. has been incorporated by Samuel B. Laurence, John B. Summerfield and Burnham C. Stickney; to deal in insulated wire and other goods, wares, etc. Capital stock, $500,000.

Montgomery, W. Va.—Kanawha Electric Co. has been incorporated with an authorized capital of $25,000, of which amount $500 has been subscribed.

BUSINESS CHANCES.

Electrolytic Marine Salt Company.—Alice E. Beckwith, of Boston; Nelson Edwards, of New York; Clarence D. Fulton, of Watertown, Mass., and others have filed a petition in the Supreme Court, at Portland, asking that a receiver be appointed for this company. They set forth that the idea of getting gold out of salt water is a fraudulent one, and that the money obtained for that purpose was secured by false pretences. A motion has been filed by the same persons praying that Arthur B. Ryan and others be enjoined from paying out any money or disposing of property belonging to the company. It is stated that the Rev. Prescott F. Jernegan is thinking of returning to this country from Belgium and making some sort of a settlement with the company, in which he is the chief stockholder.—Ex.

Toledo, Ohio.—The Toledo Electric Co. plant has been purchased by the Toledo Traction Co. for $325,000.

Peoria, Ill.—The Diamond Electric Co. has been sold by United States Marshal Ames to George C. Bailey, of Chicago, representing the John Roebling Sons Co., of New York.

New York, N. Y.—Western Telephone Co., attachment for $362 in favor of Elihu J. Granger.

Windsor, Ohio.—The Jefferson and Warren Telephone Co. has increased its capital stock from $10,000 to $20,000.

NEW YORK NOTES.

THE CITIZENS' ELECTRIC CONSTRUCTION & EQUIPMENT CO., of 39 Cortlandt street, report business as progressing. They are constructors of electric-light and power plants and are also agents for the well-known electric light and power apparatus of the Triumph Electric Co., Cincinnati, O. Mr. Frank R. Chinnock, the president and general manager of the company, has engineered some of the largest plants in the country, and has an excellent reputation as an electrical and constructing engineer.

R. A. BYRUS, manager of the Eastern agency t e Ohio Brass Co., of Mansfield, O., has opened up offices at 39-41 Cortlandt street, Room 59. He will carry a full line of his company's noted trolley materials.

L. O. FRORUP, of Schiff, Jordan & Co., 232 Greenwich street, has just returned from an extended trip through the South and reports good business. Mr. Frorup is well satisfied with his trip, having made a number of new connections and also opened up accounts with many large buyers.

THE ABENDROTH & ROOT MFG. CO., 28 Cliff street, report a large number of orders recently received for their Root's spiral riveted pipe. The great strength and durability of this style of water-pipe, the ease with which it may be handled, and the fact that it is not liable to give trouble through leakage, have created a steadily increasing demand for Root's Spiral Riveted Pipe. They have lately shipped to the Sheely & O'Shee Co., contractors, of Lincoln, Neb., 12,000 feet of their pipe which will be used in extending the water-works at Lanesboro, Minn. About 10,000 feet have been sent to Milledgeville, Ill., and 15,000 feet to the city of Augusta, Wis. The U. S. Water & Steam Supply Co., contractors, Kansas City, have placed an order with the company for about 5,000 feet of pipe which will be used at Concordia, Mo., and 6,500 feet are to go to J. L. White, contractor, Wyoming, Ill.

MR. M. COKELEY, probably known to many of our readers, has been appointed superintendent of the works of the C. W. Hunt Co., Staten Island, N. Y., and assumed the duties of that position on October 14th, after several months' work revising the factory systems.

Large concerns are beginning to relieve the office management of the responsibility of looking after the details in office routine, the installation of systems, methods, etc. This work properly belongs to a specialist; one who has become expert through constantly keeping his eyes open for improvement, studying the best literature on the subject and devoting his energies entirely to this work.

Mr. Cokeley has made this line of work his profession for some time, having been for many years with the General Electric Co. and later on with other prominent firms.

His experience as a practical mechanic has been of great benefit to him in this line of work, enabling him to detect almost instantly the leaks that invariably exist and which are so destructive to profits.

INVENTORS...

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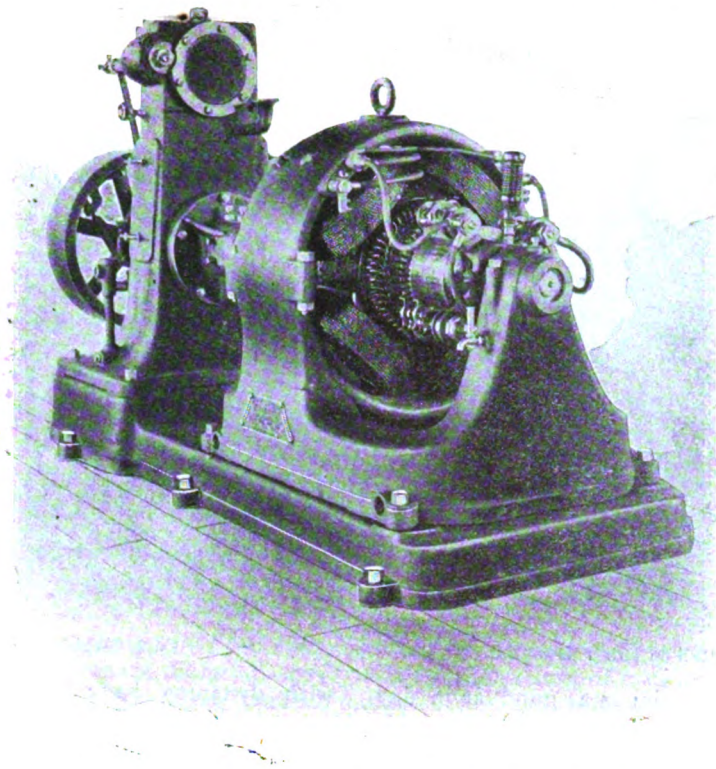
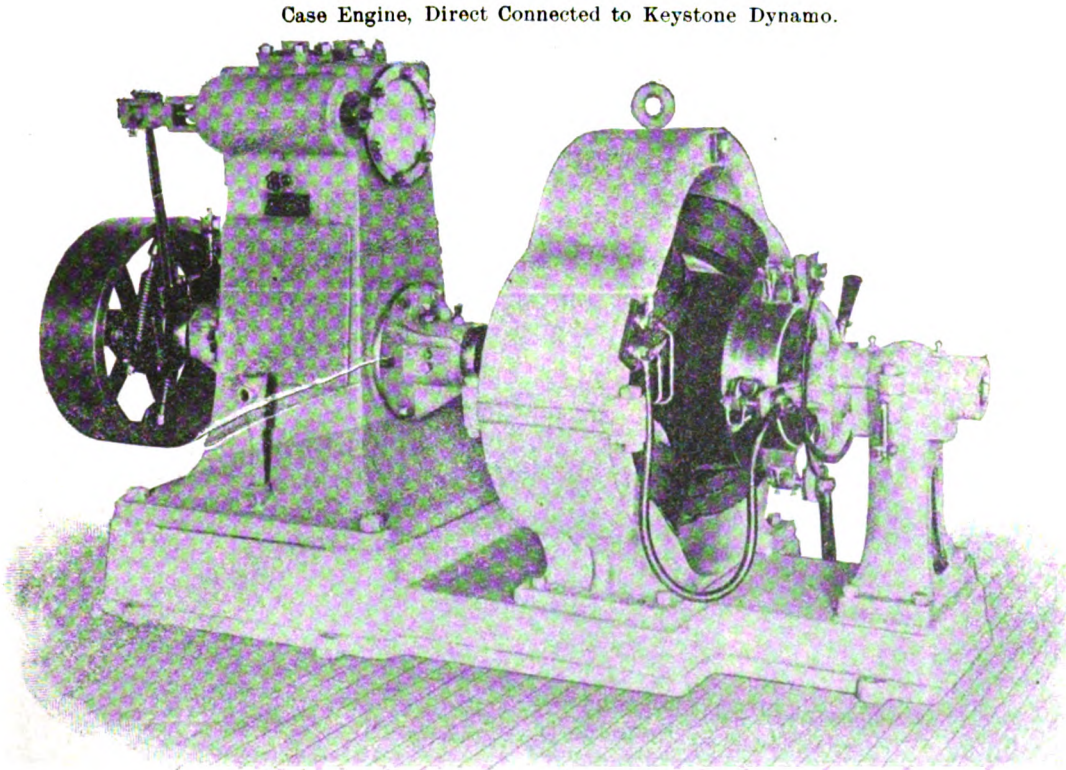
The Electrical Age.

VOL. XXII—NO. 18 NEW YORK, OCTOBER 29, 1898 WHOLE NO. 598

ELECTRIC LIGHT AND POWER.



Case Engine, Direct Connected to Keystone Dynamo.



Case Engine Direct Connected to Onondaga Dynamo.

HIGH-SPEED ELECTRIC-LIGHT PLANTS.

Wherever there is civilization the demand for light has been in proportion to the stage of cultivation it represents. In large cities the streets are well lighted, and private residences and office buildings gleam at night with electric light. One of the most novel applications of electricity is to be found in the Buffalo Bill Company. This enterprising Westerner carries with him an entire electric-light plant which operates a glittering display of focussing lamps each night his entertainment is in progress. For four seasons Buffalo Bill has carried his sta-

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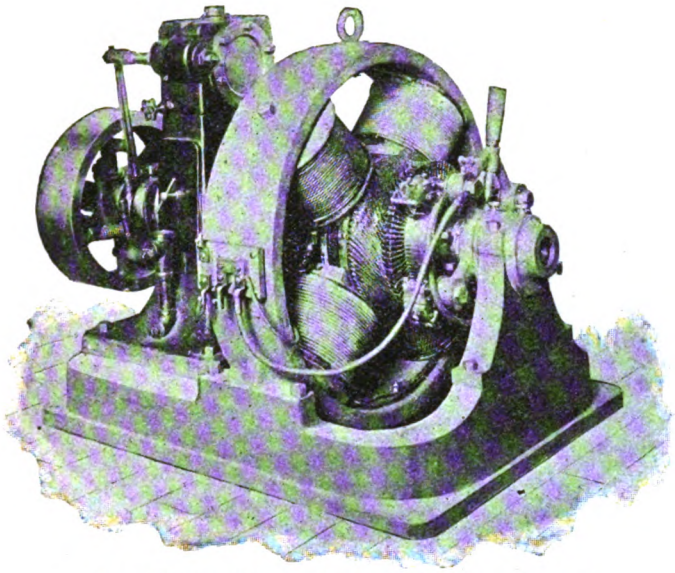
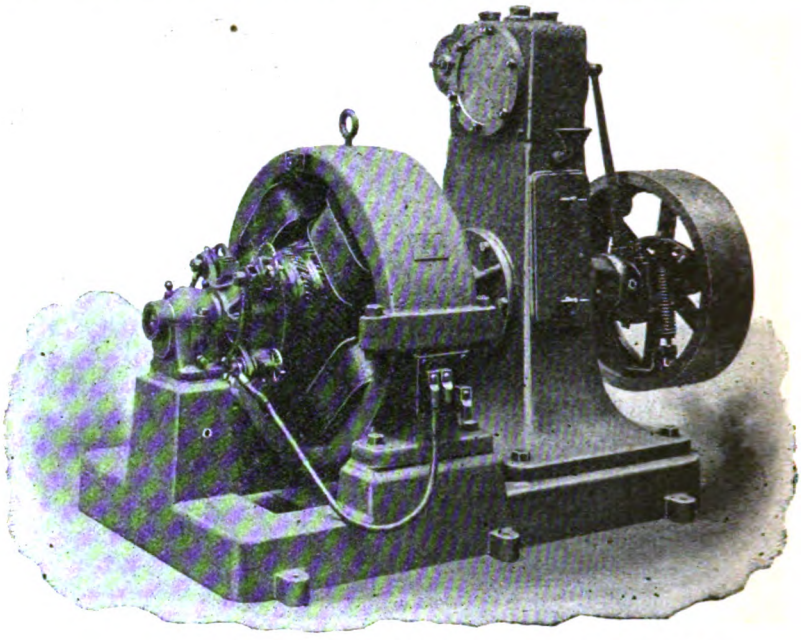
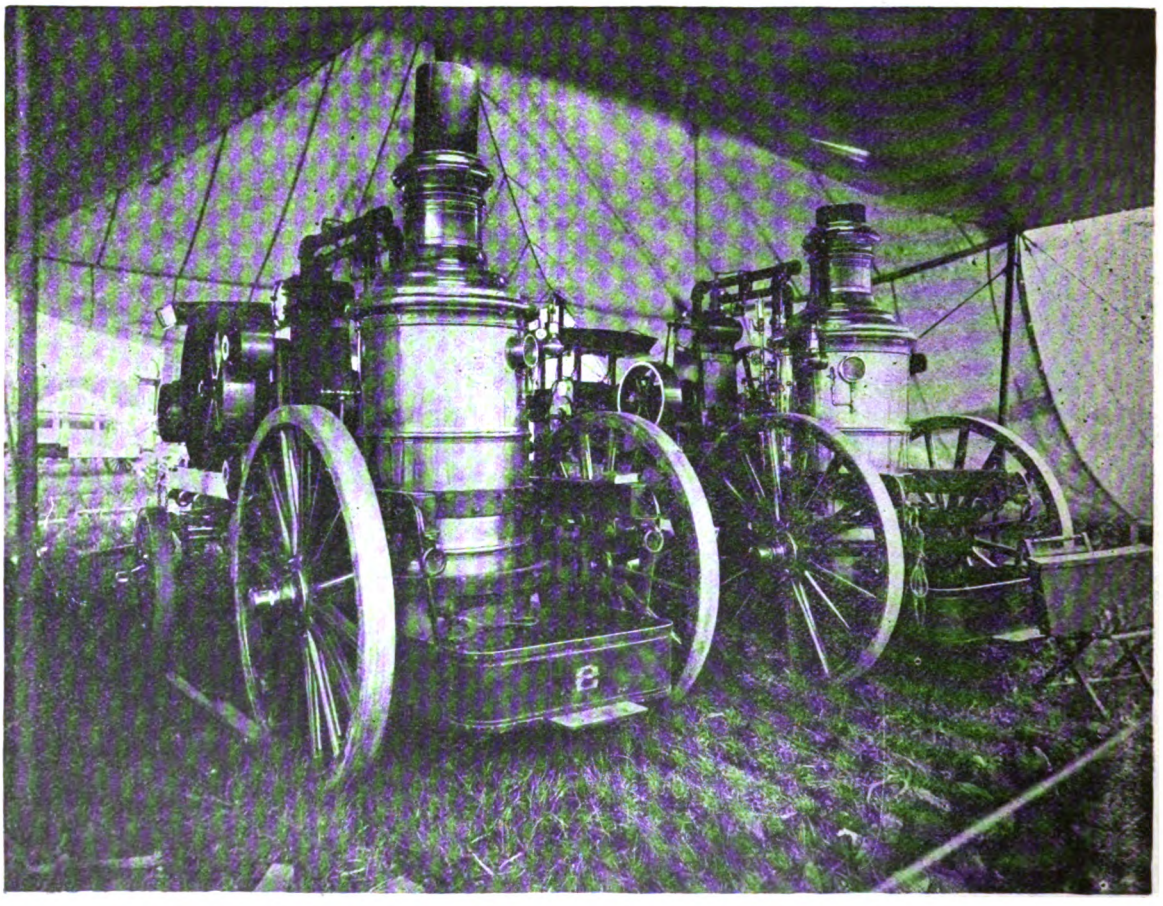
tion with him, and with a brilliancy unparalleled has illuminated the arena so successfully that the sharpshooters, the dead shots, racing around on their wild bronchos, are able to make a successful play for the clay pigeons at night. The accuracy of their aim is as good as in daylight, and at least five millions of the American public can testify to the success from an electrical standpoint of Buffalo Bill's enterprise. The portability of his outfit is entirely due to the fact that the two Case engine-driven plants represent a degree of compactness and lightness hitherto unparalleled. The application of the Case engine for special cases of electric lighting does not cease here, but on board yachts, and even on some of the steamers plying the Yukon river in the far Northwest, the light weight, small size, high economy and excellent operation of these engines in direct connection with dynamos have made them famous. The name earned by a mechanical device, and the reputation it is obliged to sustain, represents as much unconscious as that put forth by a living and thinking individual.



Case Engine Direct Connected to Riker Dynamo.



Case Engine and 7½ Kilowatt Bernard Dynamo.



Two No. 5D Case Engines, Operating Lighting Outfit, Buffalo Bill's Wild West Show.

The remarkable adaptability and the possession of a series of superior qualities have made the Case engine peculiarly fitted for electrical light work. As far as compactness is concerned the Case engine, in combination

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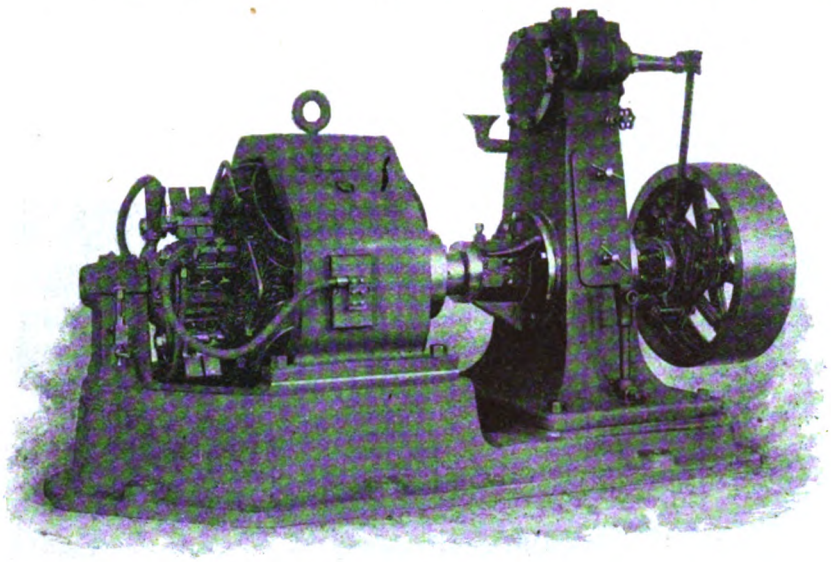
with a dynamo, possesses all advantages over others. This feature, however, is but one of its minor qualities. With a generator to which, as shown, it is direct-connected, the Case engine regulates so that a fluctuation in speed never occurs, and the voltage supplied by the dynamo preserves an unvarying uniformity. Under such circumstances a light that flickers cannot be produced; the steadiness of the illumination engendering perfect satisfaction to the purchaser.



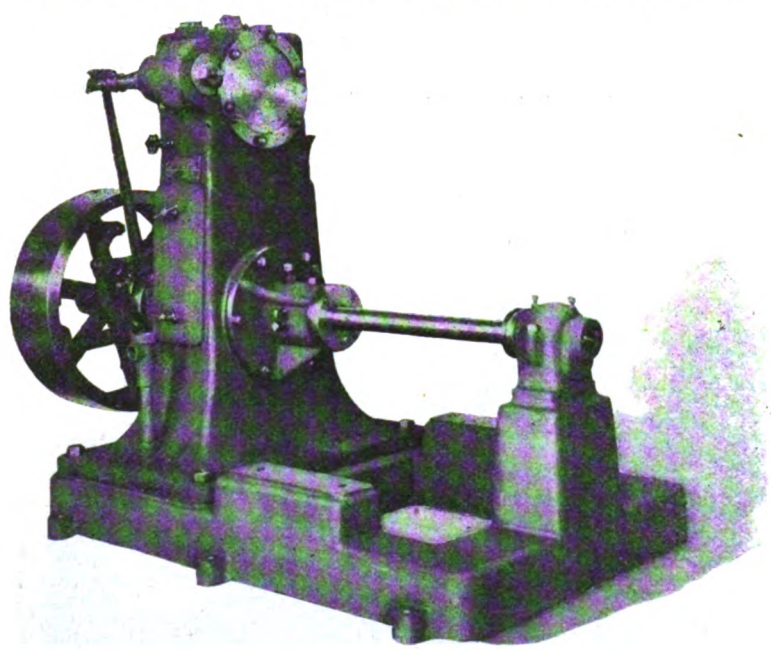
Case Engine, Direct Connected to Eddy Dynamo.

Where floor space becomes a matter of great expense, it is highly likely that considerations relating to the area occupied receives first consideration in the eyes of possible installers. In such a case common sense dictates the use of machinery whose factor of economy must not only be considered but the floor space it occupies as well.

One of the original difficulties experienced in the early history of electric lighting may be traced directly to the use of plants requiring an extensive area for their installation. Practice, however, has so changed, that size, weight, economy and floor space are considered collectively. Therefore electric-light plants deficient in any of these respects do not comply with the requirements of engineering practice and must meet with opposition, when their installation is completed, if at all deficient.

Competition is truly the spirit of business, not only from the layman's point of view in forcing prices down to their lowest, but in bringing upon the market machinery which invariably denotes care and judgment in its design and economy in its operation. Competition gives rise to a demand on the part of the public for machinery requiring a minimum of care and attention—a simplicity in construction that brings with it long life and durability to working parts.

From a purely technical standpoint the Case steam engine, in direct connection with any of our well made generators, comprises a plant which possesses all the features outlined above. It forms an outfit of great simplicity, occupying but little room and requiring but occasional supervision on the part of an attendant. The automatic oiling feature is noteworthy, and, notwithstanding the engine's compact form, everything is readily accessible; the character of workmanship no less than the size of the bearings and light-moving parts contributing to its smooth running qualities under all changes of load which are promptly met by a refined governor. These engines are made in sizes of from two and one-half to twenty-five horse-power.



Engine and Sub-base Fitted with Bernard Dynamo Used on U. S. Government Contract.

The valve motion, oiling devices, governor, bringing

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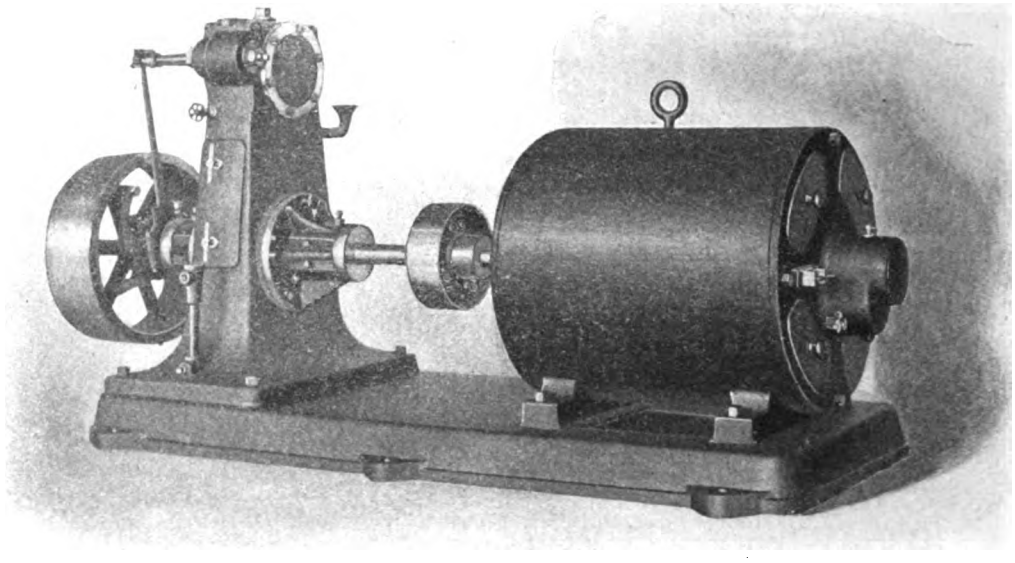
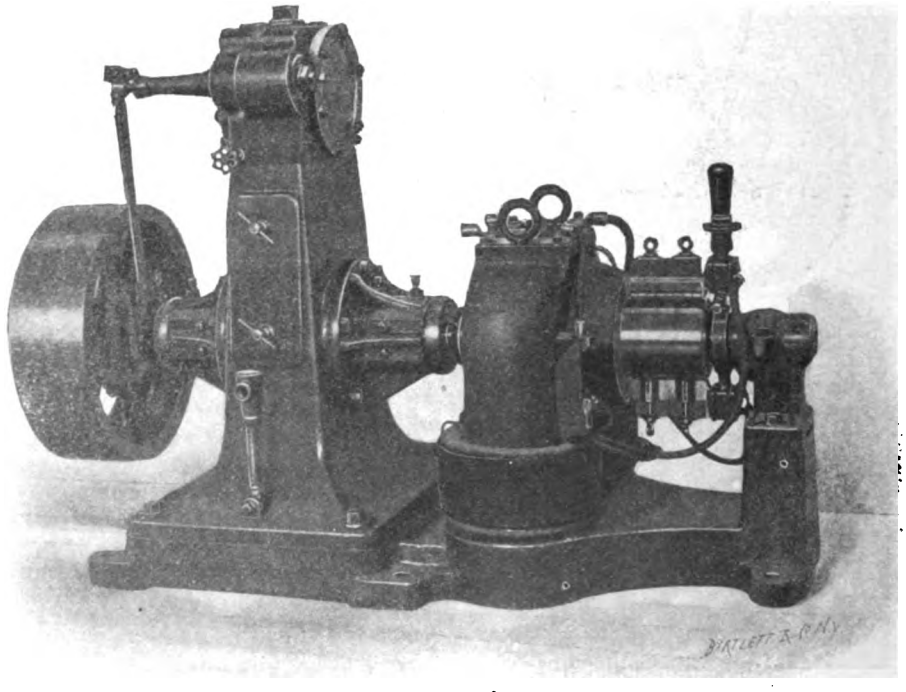
about perfect regulation and general economy make it only necessary, in order to possess a perfect lighting plant, to attach it to an Eddy, Lundell, Crocker-Wheeler, Bernard, Bullock, or other standard type of dynamo. The smooth operation of an electric light in a purely mechanical sense is perfectly useless unless attended by a similar smoothness in operation on the part of the dynamo when subjected to sudden changes in load. This in itself in the main is a test that every installation must pass through before it can be considered above criticism.



Case Engine, Direct Connected to C. & C. Dynamo.

For special lighting, isolated plants, marine lighting, factory lighting and train lighting, the New Britain Machine Company have met with unusual success in introducing their Case engines co-operating with dynamos. For train lighting particularly such a plant may be carried in the end of the baggage car, supplied with steam from the locomotive, and will hold its speed and give light, which will contribute materially to the luxury of modern railway travel, entirely independent of the train's motion. The engine and dynamo running on a Texas Midland railroad train, installed by the St. Charles Car Company, have given excellent satisfaction. In summer the advantages of this system are eloquently proclaimed by passengers, travelling back and forth, to whom the absence of a vitiated atmosphere, ill smells from oil and gas and the danger attendant upon their use means a pleasure untold.

Electric lighting, according to the most modern methods and involving the use of high-class machinery, is no longer either an experiment or a luxury. Electric lighting has like all luxuries, by the prevalence of its use, become a necessity, and it is only natural for those desirous of employing this useful servant through a belief of this kind to obtain the most compact and most efficient machinery the market affords. The New Britain Machine Company, of New Britain, Conn., manufacture the Case engine, and we advise prospective purchasers of electric-light plants with limited floor space, limited allowance for weight, etc., to correspond with this concern.



No. 4 Case Engine, Direct Connected to Crocker-Wheeler Dynamo.

The Case engine also played quite a part during the late Hispano-American war. The tender "Mangrove,"

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The Electrical Age.

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THE INCREASING USE OF THREE-PHASE MACHINERY.

The labors of Tesla, Dobrowolsky, Bradley and others have not been without their influence in developing what has now become one of the greatest departments of electrical engineering. The close of this century embraces the efforts of many great scientists, the work of each being consistently practical and in every way assisting in the crystallization of certain principles fit for different commercial applications. No problem seems more difficult to solve than that relating to the efficient generation, transmission and distribution of alternating currents, yet the very difficulties presented were but stepping stones to ultimate success.

Three-phase and polyphase machinery is accepted as the true solution in practice of one of the greatest problems of the age, the transmission of electrical energy. Niagara Falls, the power of which has dissipated itself for untold centuries upon the yielding rock, has now been curbed and bridled, and part of its resistless spirit flows with rapid pulsations into the heart of Buffalo. In regions further west, where the picturesque grandeur of the scenery is only relieved by gigantic mountain tops, where the hammer and pick do their work into the heart of rocky precipices, the thread-like lines leading from some distant station transmit the power which assists the miner and refiner of the crude ore. In many cases, where to obtain power other than electricity is well-nigh impossible, the great and palpable advantages of the three-phase system of transmission are so evident that in the majority of cases along the Pacific slope and further north to the very confines of this territory the alternating-current polyphase plant fills a want that has existed since the days of Tubal Cain.

A great deal of our industrial work in the West, the benefits of which have been felt along the eastern coast as well, has been stimulated to a healthy growth by the use of cheap and convenient power transmitted as electrical energy. One of the most startling innovations of modern times is that relating to the use of wave motion.

The possibilities of generating power from the force of the waves open up new vistas of prosperity. This power transformed into polyphase currents may be sent from large stations erected at the water's edge to innumerable towns and villages in the near vicinity. Illumination of the brightest kind will prevail at night, and power would be used ad libitum by those following an occupation allied with the manufacturing arts. The flexibility of this electrical system of generating and transmitting energy has added to the world's quota of good things that which will mean busy factories, heavy shipments of machinery and the employment of skilled and unskilled labor on the largest imaginable scale.

Side by side with the manufacture and application of polyphase machinery may be found a great burst of industrial activity on the part of those that manufacture water-power appliances. Thus it is that hand in hand a healthy growth in one branch of science brings about a corresponding development in another.

All of our great and glorious West is under the spell of the electrician. Water power plants reign supreme, and the magic touch of Progress has given new life to some small and sparsely settled locality that required the influence of a new and prospering art to bring about a change for the better. Not only need the electrician be thankful to those that have given us our present system of polyphase transmission and the machinery its use entails, but the world at large, and particularly those sections of it undergoing improvement, should thank those that have given to them the ready means of industrial advancement.

The ratio of increase in wealth is in many respects in direct proportion to the manufacturing capacity of a land, and this manufacturing capacity, this power of turning out new and improved types of machinery, depends specifically upon the minds of such men as those mentioned above. The standard of invention is raising year by year, and the combinations and recombinations daily occurring and patented by the thousands each year will soon give rise to a degree of civilization unutterably beyond any that has previously existed. As the cable has welded together continents so that they have become as one, so will the inventive ability of our citizens bring into closer touch the elements composing this great Republic. The hour is ripe for great departures, and it is our pleasure to state that among the noted inventions displayed at the coming Paris exposition few will excel in simplicity and value those relating to the use or generation of polyphase currents.

Nernst, of Goettingen, has invented an incandescent electric light in which the filament is of the same material as that used for the mantles of the incandescent gaslight. The production of the necessary temperature requires a smaller current with the new filament than with the carbonized filaments already in use, and there is no need to have the filament in a vacuum.—Ex.

The possibilities of electrical combination locks for cash drawers and similar receptacles does not seem to have been realized to its fullest extent. It requires but little ingenuity to arrange four or five push buttons in such a way that only one combination will close the circuit of an unlocking magnet, and any other will ring an alarm. The alarm could be placed at any convenient point, and at other points could be placed cut-out switches which, when manipulated, would render it impossible even for one who knew the combination to succeed in opening it. The device is easily developed and marketable.—Ex.

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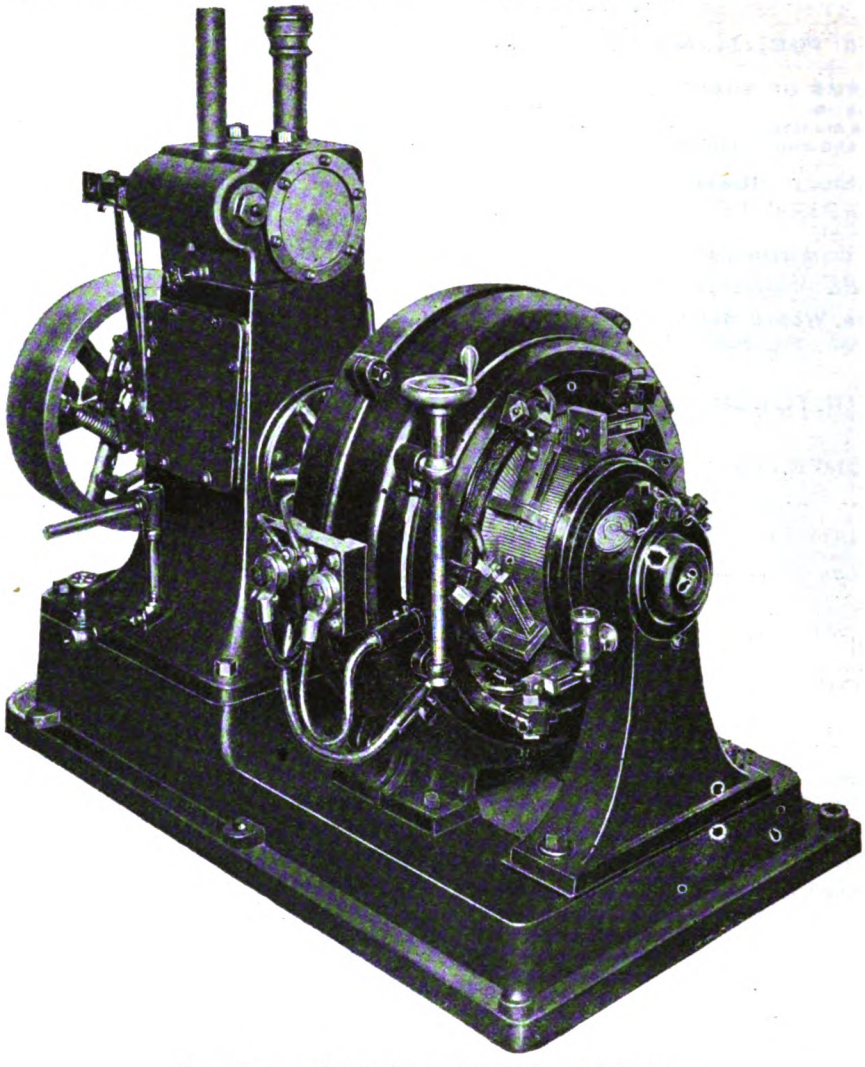
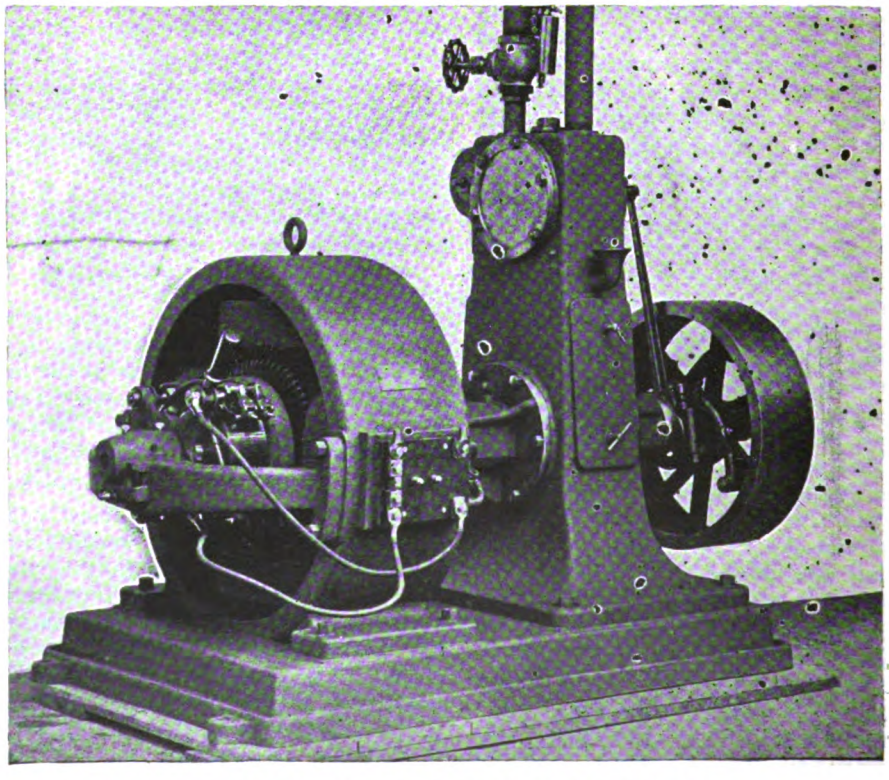
the first vessel to be sent to Cuban waters after the destruction of the battleship "Maine," was equipped with a first-class electric light plant, the motive power of which was furnished by a Case engine. The divers engaged in the task of examining the hull of the ill-fated vessel were greatly hampered by the muddy waters for



Case Engine, Direct Connected to Lundell Dynamo.



Case Engine Direct Connected to Bullock Dynamo.

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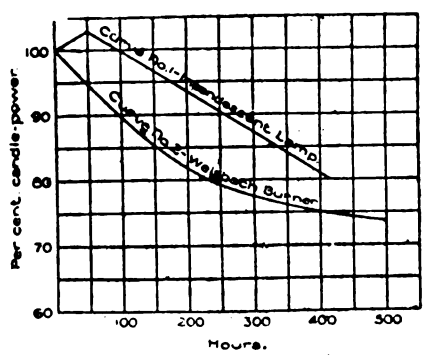
which the bay of Havana is notorious, and which made seeing under water an impossibility. Upon learning of the arrival of the "Mangrove," the divers hit upon the idea of using the current generated by the "Mangrove's" electric light plant for lighting beneath the water, which plan met with the greatest success and enabled them to arrive at the desired result. Naval Constructor Hobson's operations at Santiago in raising the sunken Spanish ships are being facilitated by the Case engine driving the searchlight on board the wrecking tug.

Lieut. Peary also took with him on his Polar expedition a four H. P. engine to drive a dynamo for furnishing light for his Greenland hut during the long Arctic night.

LIGHTING.

DEPRECIATION OF CANDLE-POWER OF WELSBACH MANTLES.

Gas companies have very generally claimed that the mantles used with Welsbach burners maintain their candle power practically constant until the mantles are destroyed. Recent investigations, however, show that the depreciation of candle power in Welsbach mantles is as rapid, or even more rapid than in the filaments of incandescent lamps. The accompanying curves show the average results of a series of tests made on incandescent lamps of General Electric manufacture and Welsbach burners.



Curve No. 1 shows that a good 32-C. P. incandescent lamp burns 415 hours before its candle power drops to 80 per cent. of the initial value. Curve No. 2 shows that a Welsbach burner suffers the same depreciation in only 230 hours. In other words, the depreciation of the Welsbach mantle is so much greater than that of the incandescent filament that the Welsbach burner drops to 80 per cent. of its initial candle power 185 hours sooner than the incandescent lamp.

Economy dictates the substitution of a new incandescent lamp when the initial candle power has depreciated to 80 per cent., but taking into account the high first cost of Welsbach mantles and the low cost of operation, a mantle would undoubtedly be continued in use until its candle power had dropped much lower. In this case, the customer would be obliged to consume the same amount of gas, and thus be at the same expense, although the light obtained would be much diminished in power. For example, if a Welsbach mantle having an initial candle power of 32 were burned for 500 hours, its candle power, according to the curve, would drop about 27 per cent., leaving approximately 23.4 candles.

Attention has recently been called to this interesting subject by the following quotation from an English paper:

"In view of the extending use of the incandescent system of gas illumination and the unequal illuminating power which has been experienced with mantles of various kinds, any really scientific investigation into the relative value of different mantles is a welcome addition to our stock of technical information.

"An interesting report of a number of tests of such mantles is given in the 'Electrical Review' (London, December 10, 1897) by Mr. E. A. Medley, with much valuable information in general about incandescent gas lighting. Mr. Medley had made some tests on the Incandescent Gas Light Company's mantles as long ago as 1893, and these he refers to as showing the improvement which has been made since that time. The tests referred to in the present report were made in Berlin, and include not only the two English mantles of the Sunlight and the Incandescent Gas Light Companies, but also those of the German concerns, including Die Deutsche Gasgluhlicht Aktiengesellschaft, Die Neue Gasgluhlich Aktiengesellschaft, and the Stabil Mantle.

"The standard of light used was the Heffner amyl acetate lamp, in connection with a Lummer-Brodhun photometer, the gas being measured by an Elster experimental gas meter. Much care was taken to secure uniform and reliable results, the room being thoroughly ventilated, and draughts at the same time avoided, as it has been found that the light is materially affected if there is not an ample supply of fresh air. The horizontal candle power was measured in three directions, 120° apart, and the mean taken as the correct reading, the measurements being taken every twenty-four hours. The details of the tests are given in full in the paper, and we can here give only the final table, which contains practically all the important results. It will be noticed that one of the German mantles, the Stabil mantle, is decidedly superior to any of the others either English or German.

NAME OF MANTLE.	Candle power.			Percentage Fall.	
	New.	100 Hrs.	500 Hrs.	In 100 Hrs.	In 500 Hrs.
Sunlight Company....	36.	33.4	14.	7.2	61.2
Incandescent Gas Light Company....	52.9	49.	29.7	7.4	43.8
Deutsche Gasgluhlicht Aktiengesellschaft..	70.3	49.7	28.2	29.3	59.9
Neue Gasgluhlicht Aktiengesellschaft	53.5	40.3	33.3	24.7	37.7
Stabil Mantel.....	62.6	57.1	47.5	8.8	24.1

"An important feature in connection with incandescent gas burners is that of the proportion of the size of the mantle to the Bunsen burner. In many cases the mantle is much too large for the burner, and, in consequence, does not become properly incandescent all over; it also shrinks and warps out of shape to a much greater extent than when smaller. Tests also showed that the light absorbed by mica chimneys as compared with glass was as much as 9.4 per cent.

"Mr. Medley's general conclusions are summed up as follows:

"The mantles give a wonderfully good light when new, but the extreme rapidity with which the light falls off and the consequent shortness of their efficient life, even when treated with every consideration due to their some-

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what delicate constitutions, makes them far from an ideal illuminant. With the possible exception of the Stabil mantles, a great deal of improvement is necessary before, for domestic lighting at any rate, they can be considered even satisfactory."

The depreciation of candle power of mantles in the Welsbach system should be thoroughly considered in connection with the heat given out, consumption of oxygen from the air, contamination of the air, inconvenience of lighting, danger from fire, and other disadvantages which are common to any gas system.

The enclosed arc lamps which the General Electric Company has developed give all the advantages of an electric system of illumination, and at the same time the cost per candle power of the light is much lower than with the Welsbach burner or other illuminants. In fact, present indications are that enclosed arc lamps will eventually replace all Welsbach burners.

OPINIONS OF EXPERTS.

THE PRESENT STATUS OF ELECTRICAL ENGINEERING IN THE UNITED STATES.

By Dr. A. E. Kennelly.

(Continued from page 224.)

The principal engineering value of electricity today lies in its adaptation to the transmission of power through mills or cities, or from some locality where power is cheap to others where it is dear. A steel rope by its bodily motion can transmit, with appreciable friction and depreciaton, some hundreds of kilowatts to a distance of some thousands of feet. A bare quiescent copper rope, one-half inch in diameter, and supported on poles, can by maintaining an effective potential of 10,000 volts by the motion of electric waves over its surface, transmit, say, 2,500 kw. with an energy loss of two-thirds per cent. per mile, and with practically no depreciation except that of the poles and supports.

The use of high pressures has thus become more frequent during the last few years. Alternating-current generators are now made to supply 10,000 volts at their terminals, and insulation testing sets have been made for producing alternating pressures up to 100,000 volts effective.

The application of electric power to domestic use and household comforts, irrespective of illumination, has made steady progress. In the large cities the fan-motor day load of summer is, in the aggregate, a perceptible quantity, while electric ranges and heaters on a small scale have found favor through their convenience.

In telegraphy, comparatively little change has recently taken place beyond the substitution of the dynamo or dynamotor for the voltaic battery, and of copper-line wire with some five ohms per mile for iron wire with some 13 ohms per mile. About 1,000,000 miles of telegraph wire are now strung on about 200,000 miles of pole line in the United States, connecting about 25,000 offices, and working an invested capital of about $150,000,000.

In the United States, the uniformity of the closed-circuit Morse system, simplex, duplex, or quadruplex, is varied only by an occasional Wheatstone set. This crystallization of methods is not due to any lack of invention or capability of improvement in signaling speed, but rather to the apparently settled belief that the present systems are the most economical under existing conditions of traffic. In long submarine telegraphy, the pressure of increasing traffic has made itself more distinctly felt, but the physical difficulties in the way of attaining high speeds have, as yet, been obviated only in part by an increased expenditure in copper and gutta-percha, to obtain a diminished conductor resistance per mile. Wireless telegraphy has entered its experimental stage, and bids fair to enter practical service in the future, at least within a limited range.

In telephony the most notable improvement in recent years has been the general substitution of metallic circuits for ground return circuits, with great advantage to the convenience and effectiveness of the service. At the present time conversation is carried on commercially up to a distance of 1,800 miles, and quite frequently at distances of 1,500 miles. There are at the present time in the United States about 1,000,000 telephones connected with the telephone service of the country, employing a capitalization of about $100,000,000, 400,000 stations, and about 900,000 miles of wire. Every day about 17,000 employés make on the average more than 3,000,000 connections. About 300,000 miles, or nearly one-third of the total length of telephone wires, have within the last few years been made up into aerial and subterranean cables, within city limits, owing to the reduction of the electrostatic capacity effects in such cabled wires to less than one-twelfth of a microfarad per mile.

A considerable development has occurred in electro-thermic and electrolytic processes. More than 4,000 kw. of Niagara power are now employed in such processes. Among electro-chemical processes are the electrolytic refining of copper to the extent of about 150,000 tons annually, the production of aluminum, the production of sodium and alkalies, and the treatment of ores. Among electro-thermic processes are the production of the carbides of silicon and calcium in steadily increasing quantities.

In electro-technical theory considerable advance has been made of recent years, particularly in the study of alternating currents. Accompanying the expansion of knowledge in the various branches, there is a tendency among them to combine and unite into one general theory. Thus, while the low-tension electricity of dynamo origin was once regarded as something so dissimilar to high-tension electricity as to require separate treatment and classification, today the high tensions derived from alternators through step-up transformers so far invade the territory of so-called frictional electricity that a dividing line between the two classes can no longer be maintained. Similarly telephony and telegraphy are coming to be regarded as sub-classes of alternating-current power transmission, while electricity and magnetism cannot properly be studied apart.

VACUUM TUBE LIGHTING.

THE THEORY OF SUNLIGHT.

Experiments made recently by Francke L. Woodward, Harvard, '96, to determine the penetrability of a vacuum by light, have led him to conclude that, owing to the presumable vacuum existing between the atmosphere of the earth and that of the sun, the rays generated by the sun must be a form of cathode rays, or we would get no sunlight whatever. The theory is radical, and, if confirmed by other experimenters, will set at naught the accepted ideas of transmission of light through space.

The investigator used a glass tube, exhausted of air as much as is today possible, covered with black paper, in which were cut two circular openings at opposite ends of a diameter to enable the passage of light. A beam of lime light was sent across the tube through these openings. As it left the second opening its intensity was only about one-twentieth of that it had on entering. It was found that the more perfect the vacuum the less was the intensity of the light. It would therefore seem that, granted an actual vacuum were obtainable, no lime light whatever would emerge from the second opening.

Next cathode rays were sent through the tube. They came out of the second opening with almost the same intensity they had on entrance, proving the penetrability of

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the X ray. This tends to support Tesla's theory that Roentgen rays consist of a stream of material particles capable of passing through the glass walls of a bulb. When these particles enter the bulb the transmission of light is facilitated. It would follow from this, then, that light can only be transmitted where material particles as well as ether are present.

In regard therefore to the transmission of light from the sun to the earth, it seems reasonable to conclude, in view of his experiments, that if, as is supposed, a perfect vacuum exists between the sun and the earth, the rays of light generated by the sun are transformed in traversing this vacuum and our atmosphere.

There are also some astronomical and meteorological phenomena which support the theory of the existence of a cathode stream from the sun. According to the theory of comets, which is now most in favor, tails of comets are due to a cathode stream, such as Crookes found to proceed from an obstruction placed in the main cathode stream. The aurora borealis has also been explained by Birkeland on the assumption that it consists of cathode streams in the upper region of the atmosphere, directed and controlled by the earth's magnetism.

(To be continued.)

ELECTRIC LIGHT AND POWER.

POSITIVE AND NEGATIVE ECONOMIES IN THE OPERATION OF SMALL ELECTRIC LIGHT PLANTS.

(Continued from Page 236.)

Everyone knows that a good fireman can save 25 per cent. to 50 per cent. of the coal used by a poor one, or by the good one if he is not intelligently checked. This last remark is not always added. Possibly the heating surfaces are not kept clean inside and out—a conservative estimate of loss is 5 per cent., to 15 per cent. Next, that the settings are not tight—loss 2 per cent. to 5 per cent.; grates too large or too small, with fires too thin and in holes, or too thick for the draft and the coal—loss 10 per cent. to 20 per cent. Perhaps coal at $1.25 a ton is being used and evaporating less water per dollar than coal at $1.50. Possibly changes in the furnace would reverse the case and the $1.25 coal would be a positive instead of a negative economy. Often the feed water is at a lower temperature than necessary, possibly saving up to 15 per cent. Perhaps a new boiler is needed, or a larger stack. The saving to be effected and the cost can be closely approximated.

Voltage.

We will next consider the electrical end Whether A. C. or D. C. be used for incandescent lighting, the great point is to deliver at constant pressure. If the consumer furnishes his lamp renewals, it may not seem to be of great importance, but from the standpoint of giving satisfaction, it is second only to reliability. The voltage at the lamps in most town plants, and in many city plants, has, I believe, a fluctuation of over 10 per cent., and in some cases of 15 per cent. A range of not over 6 per cent. is exceptional. In very few plants is the fluctuation known, and in nearly every case where ascertained by the writer, it has been a great surprise to, and hardly credited by, the client. Most stations have a lamp breakage of 20 per cent. to 40 per cent. in excess of the amount readily obtainable.

I have some curves on this point which may interest you. In order to improve in this particular, a study of the conditions of operation, and record of voltage at a number of places is necessary, and often a great improvement can be made at a slight expense. In one case—a plant of about 3,000 lights—we found part of the town operating at a very high voltage, "because they had to for another part of the town;" 110-volt lamps were seen in use, 125 volts being noted in some cases, 100 in others. It cost about $150 to add a little wire and to take down wire in one place and put it in another, and bring the whole network so that it would rise and fall together. This was a direct-current plant. In an A. C. plant of about the same size, the difference of voltage between the different parts of the circuit, and the hourly variation, was still greater. In some places the lamps would not last, and no one was satisfied. It cost $100 to plan changes costing another hundred, and to save several dollars a day, and, still more important, satisfaction was given.

In both these cases the voltage at the station was maintained practically constant, without reference to the load, and this is a common error. Changes, to produce good results, cannot always be made so cheaply as in these cases, but generally the distribution can be improved and placed under control without an excessive expenditure.

If A. C. is used, it is important to have as large transformers and as few of them as practicable, often feeding into a network, at least in the business portion. This has been much discussed recently, and especially in the paper by W. F. White, read at the Omaha meeting of the American Institute of Electric Engineers.

Under the head of "The Devices for Transforming Electric Energy into Light or Power," the savings to be effected are largely dependent upon the distribution. High efficiency incandescent lamps, that is, those requiring the minimum watts per candle power, cannot be used if the voltage varies. The maximum difference of potential in the arc cannot be maintained, nor satisfactory light given, by constant potential arc lamps on varying voltage. Motors will not govern well if the voltage drops, and would take an excessive current if forced to do the same work as at a higher voltage. For constant current arc lamps, the rated current must be maintained. Keeping the mechanism clean, not wasting carbons, and similar details of operation, are points to watch.

Making Improvements.

To ascertain the true condition of any plant, it is necessary that it should be carefully tested by some one having a broad knowledge of such matters. He should have, not only a training as an engineer, but also as a station man, being able to discriminate between efficiencies under special conditions (important as it is to know same) and the efficiencies which can be expected in regular run, and how far it is practicable to improve same.

In conclusion: Ascertain the facts as to the present condition of operation, make such improvements as possible by better adjustment or handling.

Make such additions as will bring 15 per cent. or more on the investment, at the same time adding to the reliability and lessening the depreciation, and as fast as the necessary money can be obtained to pay for them. Keep records and study them. Obtain and maintain a desire on the part of the employes to better the record

Our principal manufacturing companies freely advertise and guarantee the specific economic performance of which each and every one of the transformers that they place upon the market is capable. They severally advertise to supply us with transformers equaling in efficiency, regulation (and what not), any other transformer that can be found upon the market.

The manufacturing companies are unanimous in their guarantees of high efficiency, low core losses, negligible ageing and close regulation. If we can purchase transformers freely on these representations, with sufficient guarantee that the specifications advertised are strictly conformed to or improved upon, there is little to be desired on the part of the purchaser over and above what is offered. Any slight improvement that it shall be possible to make upon the best of the performances advertised by the competing factories will be forthcoming in consequence of the rivalries of trade, and the purchaser need

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only seek now for means of protecting himself against occasional faulty manufacture.

When, therefore, we consider the perfection to which this type of apparatus has been brought, in its every detail, and in sizes varying in capacity from a fraction of one to over 800 kilowatt, we have cause for congratulation.

If you have followed the design and manufacture of the commercial transformer, I think you will admit that at the present time the best of them are figured just about as close as is possible, and in fact we have almost reached the point beyond which any further advance in the direction of improved efficiency must be made by getting better insulating materials, requiring less space and giving this space to the iron and copper.

With a view to investigating the present status of the transformer and the ability of transformer manufacturers to meet in all cases the exacting specifications which they have laid down for themselves, I have had a number of transformers of recent design tested in the Purdue laboratories within the last year. The results of these tests are especially gratifying when gauged from the standpoint of our present commercial requirements, and to the specialist a detailed statement of the results would be interesting. In view of the fact, however, that the electrical literature of the day contains numerous matters of this kind, I will not bore you with many figures, but rather discuss the results in a general way.

With but one exception the transformers tested have surpassed the requirements of the specifications laid down by Prof. Jackson in his excellent article on transformer testing, with which we are all familiar, and, generally speaking, they have conformed fairly closely to the published guarantees of the companies submitting the transformers for test. To what extent this is true may be better appreciated if I cite one or two examples.

A 2.5 kilowatt transformer was submitted for test that was guaranteed to conform to or improve upon the following specifications: Core loss 48 watts, regulation 2.1 per cent., and full load efficiency 96.1 per cent. The test of this transformer gave, core loss 42.19 watts, regulation 1.9 per cent., full load efficiency 96.2 per cent.

The showing made by this transformer is good. The core loss is 5.81 watts less than the stipulated value, and the efficiencies are in excess of the stipulated values. In this case the manufacturers more than substantiated their guarantee, and supplied a transformer that is a greater revenue producer than the specifications call for. If the core iron of this transformer can be relied upon as not materially increasing in its hysteretic loss with age, it is an easy matter to figure the money value of the excess economy that the transformer develops.

Suppose, for instance, a contract should be made for 40 of these transformers at $30.00 each to meet an increase in a station load of 100 kilowatts. On an all-day schedule these transformers would probably carry a commercial load equivalent to full load working for five hours. This assumption may seem to represent a better condition of service than is usually met with in practice, but it is an assumption that is fair to the manufacturer in considering the all-day efficiency. The transformers would therefore be working under no load for 6,935 hours and under full load for 1,825 hours per year, and under the conditions of the test would save 1,794 kilowatt hours to the station. If we figure the cost of producing this power ta two cents per kilowatt hour, the saving per year would be $35 88 for the forty transformers, or practically 3 per cent. on the amount invested in the transformers. If this power were sold for six cents per kilowatt hour it would represent a net gain to the purchaser of 1,794 x .06= $107.64 per year more than he had any right to expect under the contract specifications.

Another 2.5 kilowatt transformer submitted for test is advertised by the makers to show a core loss of 57 watts, a quarter load efficiency of 91 per cent., a full load efficiency of 96 per cent., a regulation of 2 per cent., and a no load current of .1 ampere. Under test it was found to have a core loss of 63.6 watts, a quarter load efficiency of 90 per cent., a full load efficiency of 94 8, a regulation of 3 per cent., and a no load current of .087.

Suppose we estimate the economy of transformers of this type just as we did those of the type previously considered. The 40 transformers, working on the same schedule, would waste 4,014 kilowatt hours more power than they should under the specifications advertised. At two cents per kilowatt hour the total money loss would be $80.00 per year, or over 6.5 per cent. of the cost price of $1,200.

Many engineers may claim that the cost of checking up the performance of the transformers would more than eat up the saving effected by the small margin that these results represent, and in many cases under the present organization this would doubtless be true, but if a well-advised stand was taken by the central station managers for mutual protection, the result would be markedly beneficial.

A percentage of the transformer output of each of the manufacturing firms could, for instance, be tested in some one place, where a record of the individual performance of all the transformers submitted for trial could be kept, and not only efficiency, but ageing and insulation and temperature trials could be made at a merely nominal expense.

But these examples do not cover the ground. I will cite two others.

In the case of a 15 kilowatt oil insulated transformer, guaranteed to develop a quarter load efficiency of 96 per cent., a full load efficiency of 97.4 per cent., and to have a regulation of 1.77 per cent., the test showed a quarter load efficiency of 94.5 per cent., a full load efficiency of 96.1 per cent., and a regulation of 1.6 per cent. The core loss of this transformer, which operates at 60 cycles, is 186.6 watts, and the specifications under which it was built require that the core loss should be about 150 watts.

It would take seven of these to give an output of 100 kilowatts—and they would cost not less than $115 each. The seven transformers in this case would waste 3,855 kilowatt hours in a year, which represents a financial loss of $77 in one year over and above the loss to be expected. This approximates 10 per cent. of the original cost of the transformers and is an item that cannot be neglected. If, on the other hand, this waste power could be sold at six cents per kilowatt hour, it would represent a part of the just return on the investment contemplated when the transformers were purchased, and would mean $221 to the company.

I do not claim that the figures which I present to you cover all the items of expense that enter into the installation of 100 kilowatts—in transformers. They do not, but they do represent a phase of the question that deserves more than passing attention at a time when competition is becoming sharper and sharper.

(To be continued.)

STRAY CURRENTS.

The provision of electricity at the forthcoming Paris Exhibition will require the use of 264 gallons of water a second. This will be taken from the Seine, and before running back will be utilized in a fairy fountain. A jet of 36 yards in height is promised.—Ex.

As a proof that the heating of a wire to redness by a current of electricity partially disintegrates it, the fact may be mentioned that when air has been so freed from suspended particles that it can no longer make a mist of condensed water or harbor electrical charges, it recovers those properties if a wire is heated to redness in it for a short time.—Ex.

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The resistance of the human adult body to the passage of a current from one hand to the other through the chest is about 15,000 ohms on the average. This no doubt explains why sparks from an electrical machine being due to small amounts of electricity do no harm, in spite of the enormous voltage. With the above resistance, 30,000 volts would only give a current of 2 amperes in the body. —Ex.

Steel for Magnets—The "American Journal of Science" gives the results of tests of a large number of magnets made of self-hardening steel, now in common use for lathe tools. The experiments show that comparatively short-seasoned magnets made of this steel have decidedly smaller induction coefficients than magnets of the same dimensions made of tool steel; the difference in the temperature coefficient is much less, but the advantage is still on the side of those made of self-hardening steel; the temperature and induction coefficients of long magnets of the two kinds of steel do not seem to be very different.—Ex.

M. Ducretet, an able French worker at the wave transmission of electricity, has produced the following effects by means of the Hertzian undulations: He has raised a long metal wire to a red heat, started an electric motor, excited (made magnetic) a powerful electromagnet, lit up a row of incandescent lamps, and exploded a mining fuse.—Ex.

BLOCK SIGNALS FOR TROLLEY ROADS.

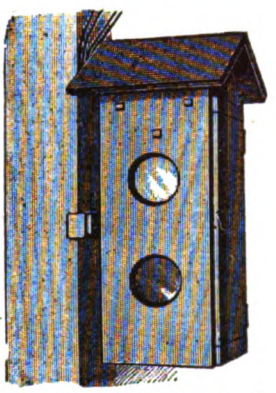
N trolley roads using single tracks it has been found necessary, in order to prevent the ever-increasing number of rear-end collisions, to adopt some method of signals, making travel on such roads as safe as that on steam railways using the most elaborate system of block signals. The Automatic Block Signal Co., of 136 Liberty street, New York City, manufacture an automatic electric block signal, which is giving the greatest satisfaction to trolley officials.

This signal automatically indicates at each end of a section of single track whether there is a car on that section or not, and the direction in which it is moving.

The cut shows the appearance of the box containing the signal. One of these boxes is placed on a pole near the turn-out at each end of a "block," or section of single track. The box has two lenses on each side, the two upper lenses having green glass and the two lower ones red glass, with a group of lamps between each pair of lenses. Each box has wires moving to automatic contacts on the "in" and "out" trolley wires of the turn-out near which it is placed. Two wires also connect the two signal boxes with each other. The trolley of a car on passing over the turn-out to enter the "block," strikes the corresponding automatic contact, which lights the lamps that show the green signal in the signal box at entering end, and the red signal at the other end of the section. On passing out of the "block," the trolley strikes the automatic contact on the "out" side of that turn-out, and this shuts off the current at both ends of the section.

All boxes are carefully constructed and equipped and given a thorough test before shipment.

Mr. E. D. McGowen, secretary-treasurer of the Charleston City Railway Company, of Charleston, S. C., stopped in this city while on his way to the Boston meeting of the A. S. R. A., and left an order for a number of signal boxes with the Automatic Block Signal Co. The Charleston company has used a number of the signal boxes for over a year, and Mr. McGowen states that there has not been a single rear-end collision since the boxes were installed and thnt all the cars have been able to run on schedule time. Rear-end collisions were an ordinary occurrence before the boxes were installed.



Automatic Electric Block Signal Box.

HOCHHAUSEN & HALL.

We take pleasure in calling the attention of our readers to the firm of Hochhausen & Hall, 67 Liberty street, Brooklyn, N. Y., electrical engineers and contractors. Messrs. Hochhausen & Hall are both young men, with a long and varied experience in electrical construction, having been associated with the Excelsior Electric Company, of Brooklyn, for a number of years. Mr. H. T. Hochhausen is the only son of William Hochhausen, founder of the Excelsior Electric Company, the pioneer arc light company of America. Messrs. Hochhausen & Hall are fully prepared to undertake all kinds of electrical construction work, as well as repair work for dynamos, motors, etc. They make a specialty of installing petroleum engines in connection with electric lignt plants, giving the preference to the Mietz & Weiss engine, manufactured in Manhattan.

In connection with their repair work they make use of a very ingenious piece of machinery for winding Gramme ring armatures. This machine can be operated by one or two men, depending upon the size of the armature to be wound, and does the work more evenly than it can be done by hand. Attached to the machine there is a special winding device, which winds each section of the armature automatically and can also be set for any tension desired on the wire.

A visit to the shop of the above firm, which is located conveniently near to the bridge, showed it in full operation, indicative of the success with which Messrs. Hochhausen & Hall are meeting.

Lockport, Ill.—People's Telephone Co. has been incorporated by Allen G. Hawley, Charles B. Cheadle and Thomas A. Cheadle. Capital stock, $12,000.

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OBITUARY.

CLARENCE G. DAVENPORT.

Clarence G. Davenport, formerly expert and agent of the General Electric Company, at 44 Broad street, who went to Porto Rico with the First Regiment Engineers, U. S. V., died of typhoid fever at Ponce on October 26th. He had been an Associate Member of the American Institute of Electrical Engineers since November 21st, 1894.

AMONG THE SOCIETIES.

NEW YORK ELECTRICAL SOCIETY.

The following is a list of members elected at the October 27th meeting of the New York Electrical Society:

Charles E. Spiers, D. Van Nostrand Co., Murray street, New York.

H. Ward Leonard, Bronxville, N. Y.

Harold P. Davis, 918 Union street, Brooklyn, N. Y.

John C. Slack, 113 Oak street, Greenpoint, Brooklyn, N. Y.

James H. Mason, 152 E. 23d street, New York.

W. F. D. Crane, Reynolds Terrace, Orange, N. J.

Dr. F. S. Kolle, 273 Prospect avenue, Brooklyn, N. Y.

William A. Brown, Jr., Assistant Chief Elec. Eng. Penna. R. R., Broad Street Station, Philadelphia, Pa.

Frank D. Sweeten, junior member Vallee Bros. & Co., 625 Arch street, Philadelphia, Pa.

William A. Brown, Chief Elec. Eng. Penna. R. R., Broad Street Station, Philadelphia, Pa.

Charles Shirley, N. Y. Mgr. Mass. Office Boston Postal Tel. Cable Co., 253 Broadway, New York.

Albert Eckert Chandler, Postal Tel. Cable Co., 253 Broadway, New York.

Edward J. Powers, 45 Cedar street, New York.

B. F. Hamilton, 510 W. 23d street, New York.

Mortimer Lewis Newman, E. E., 107 E. 90th street, New York.

Lawrence Strauss, 120 E. 117th street, New York.

G. Herbert Condict, Chief Eng. Electric Vehicle Co., 1630 Broadway, New York.

James Appleton, Chief Eng. Construction Dept. Elec. Storage Battery Co , Drexel Bldg., Philadelphia, Pa.

Dr. Jean F. Chauveau, 216 W 103d street, New York.

George N. Moore, Asst. Supt. Edison Elec. Illum. Co., 53d Street Station, New York.

James J. McKenna, Maintenance Co., St. Paul Bldg., New York.

H. B. Kirkland, 120 Liberty street, New York.

Adolph L. Goldschmidt, 425 E. 50th street, New York.

John J. Breslawsky, Leonard & McCoy, 118 Liberty street, New York; 1735 Madison avenue, New York.

John T. Hunt, Zimdars & Hunt, 127 5th avenue, New York.

Wm. M. Stewart, N. Y. Telephone Co., 15 Dey street, New York.

Horace Dowie, 363 Jefferson avenue, Brooklyn, N. Y.

Hiram D. Torrie, Jr., Riverside, N. J.

Henry M. Jackson, Pres. Peoples L. & P. Co., Newark, N. J.

Dudley Farrand, Peoples L. & P. Co., Newark, N. J.

NEW INCORPORATIONS.

Bonham, Tex.—The Bonham Electric Light & Power Co. has been incorporated by J. F. Heledge, J. B. Russell, J. N. Rainey and E. F. White. Capital stock, $25,000.

Montgomery, W. Va.—The Kanawha Electric Co. has been incorporated by J. W. Straughan, W. S. Montgomery, Jacob Sigal, E. W. McCormick and M. S. McCormick. Capital stock, $5,000.

St. Louis, Mo.—The Northwestern Electric Heat & Power Co. has been incorporated by F. W. Blees, John F. Schafer and Charles E. Roehl. Capital stock, $30,000.

Indianapolis, Ind.—Electric Therapeutic Manufacturing Co. has been incorporated, with a capital stock of $5,000.

POSSIBLE INSTALLATIONS.

Asheboro, N. C.—John T. Moffit may give information concerning establishment of an electric lighting plant.

Greensboro, N. C.—B. S. Johnson and others, of Baltimore, Md., contemplate installing an incandescent electric lighting plant in Greensboro.

Miami, Fla.—J. A. McDonald is interested in the establishment of an electric light plant.

Monroe, La.—A. A. Forsythe, Mayor, may be addressed for information concerning proposed establishment of an electric light plant.

Mountain Lake Park, Md.—The Mountain Lake Park Association contemplates the construction of an electric light plant.

Yazoo City, Miss.—L. G. Montgomery may give information concerning contemplated construction of electric lighting plant.

Salisbury, N. C.—F. E. Boardman has been granted franchise for constructing an electric light plant.

Winchester, Va.—The Winchester Gas & Electric Light Co. is considering the establishment of an arc plant.

INVENTORS...

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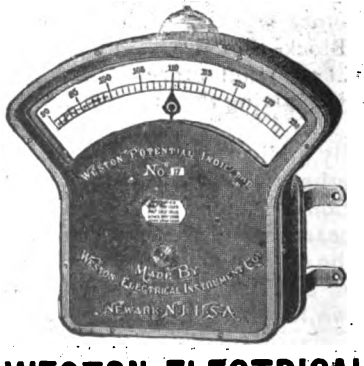

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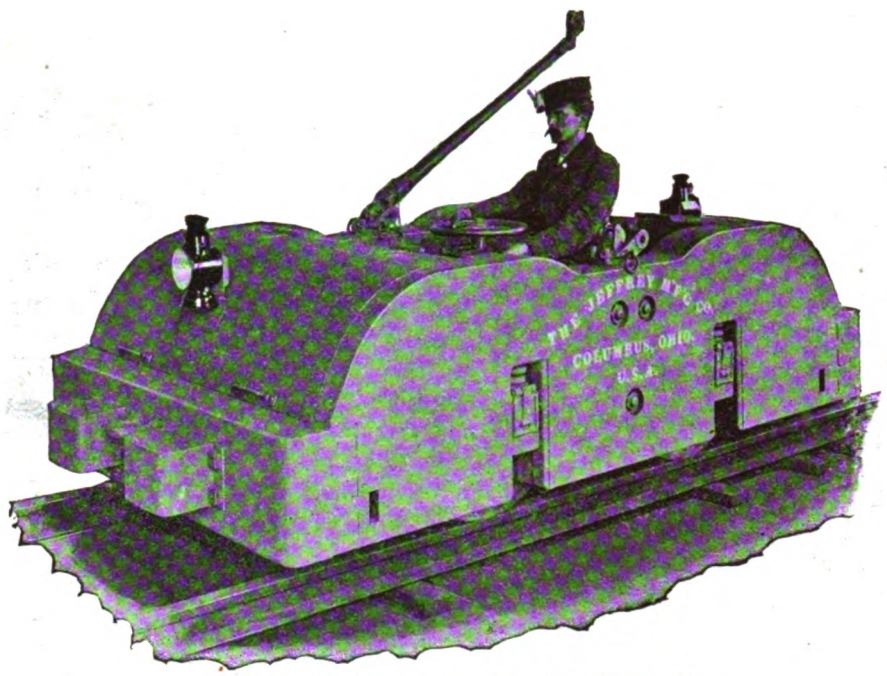
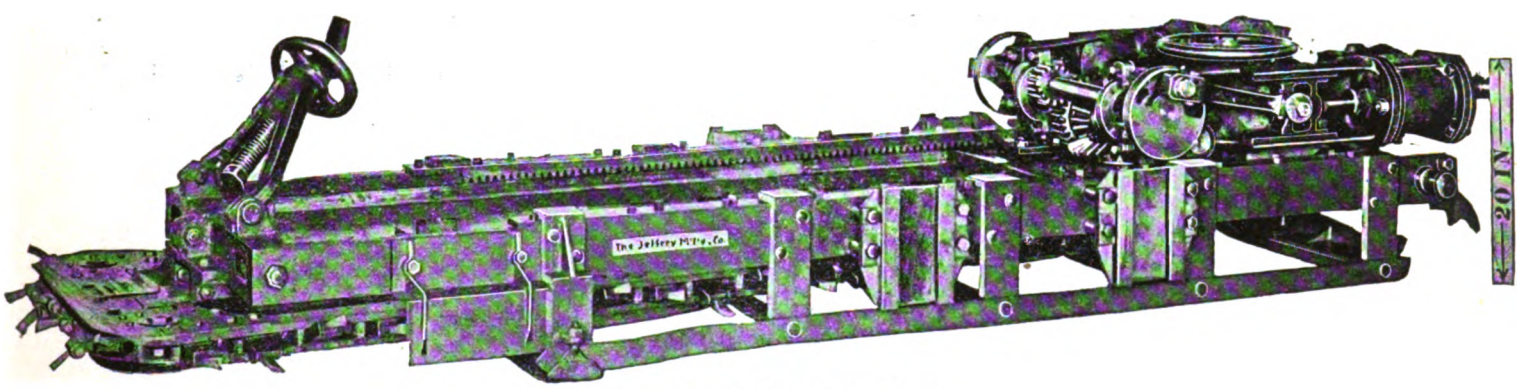
The Electrical Age.

VOL. XXII—NO. 19 NEW YORK, NOVEMBER 5, 1898 WHOLE NO. 599

ELECTRIC MINING.



Jeffrey Electric Locomotive. Man in Middle.



Jeffrey Air Chain Coal Cutting Machine.

JEFFREY ELECTRIC COAL-MINING MACHINERY

Those interested in coal-mining machinery will be interested to know that the Jeffrey Manufacturing Company, Columbus, Ohio, have recently placed on the market an improved electric chain coal-cutting machine, an illustration of which is given in this issue.

The machine as shown is constructed on lines similar to the ones previously built by this company, and is the outcome of experience gained during twenty (20) years of actual operation. It contains the necessary qualifications to make it superior to all others that have preceded it.

This company, being the pioneers in the manufacture of coal-mining machinery, have had the advantage of a great many years' experience in the construction of such machines. With this experience and a well-equipped factory they have been able to keep abreast of the times and to maintain their position as leaders.

The most marked improvement in the machine is found in the motor. This is known as the "M M 17 A" motor and is of the multipolar iron-clad armature type. It is built to perform the most severe duties to which a coal-cutting machine is subjected and is calculated to operate with minimum repairs, together with high efficiency. The frame is of cast steel; the magnetic circuit being of ample capacity to allow of no undue heating.

The armature is of the iron-clad type; that is, the wires are embedded in the cores of the armature, the outside of the armature having the appearance of a solid band; this gives protection against injury while moving

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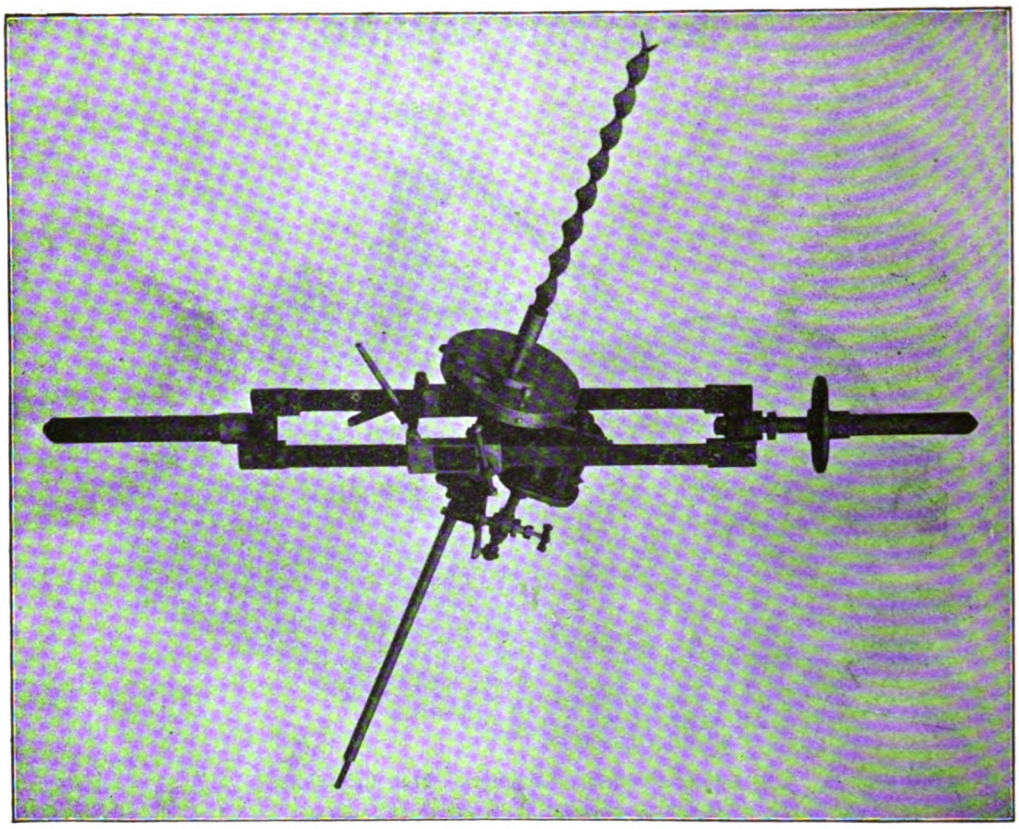
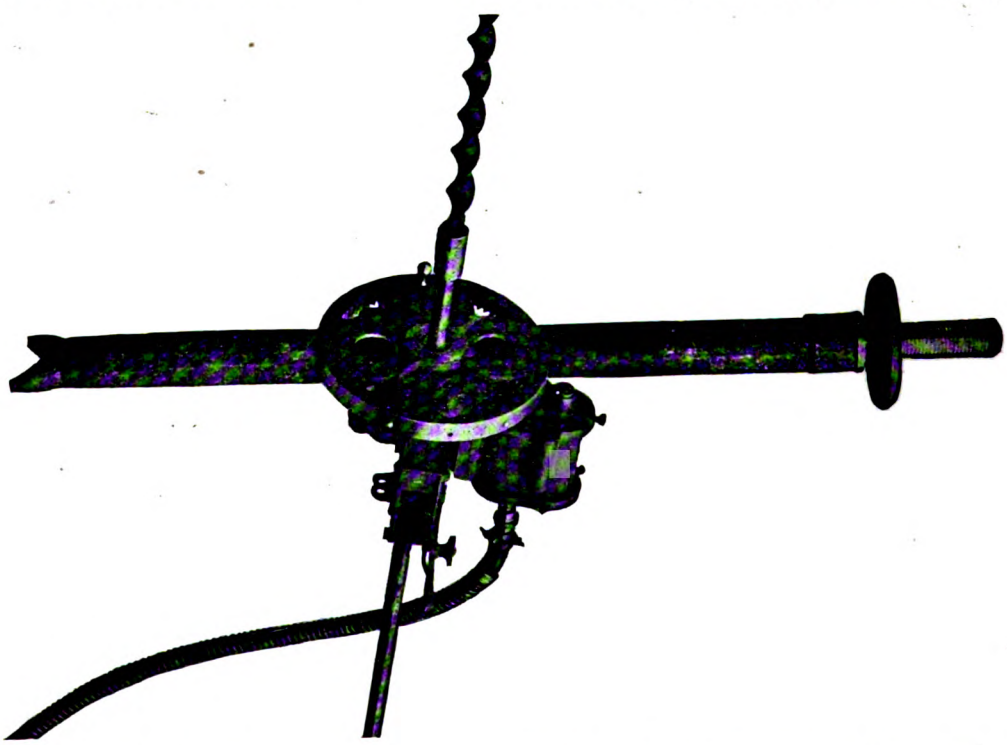
from place to place or from any unusual rough treatment it may receive; it is calculated to run continuously. The armature shaft has large and ample bearings, and the longest runs have failed to develop over-heating.



Air Power Drill.

The filled coils are of ample capacity to carry their proportion of the current at the rated capacity without undue heating, and develop an extremely low temperature after a continuous run of several hours on full load.



Jeffrey Giant Air Drill, Single Post. For great variations in height.

There is absolutely no sparking at the commutator, and the rise of temperature at this point is exceedingly small. The commutator is made of the best quality hard-drawn copper and is of ample capacity.

All pinions, worms and worm wheels are keyed on to their respective shafts. In the early machines these were forged onto the shaft and then cut; this was done in order to secure minimum space. The trouble arising from this source and the great expense attached to replacing them (it being necessary to replace shaft and gears when gear became disfigured) was so great that it was finally considered to be impracticable, and the change was made to separate shafts and separate pinions. The shafts are forged steel. The pinions are keyed to the shaft. By doing this the safety was increased and the expense decreased. The construction has been carried out for sev-

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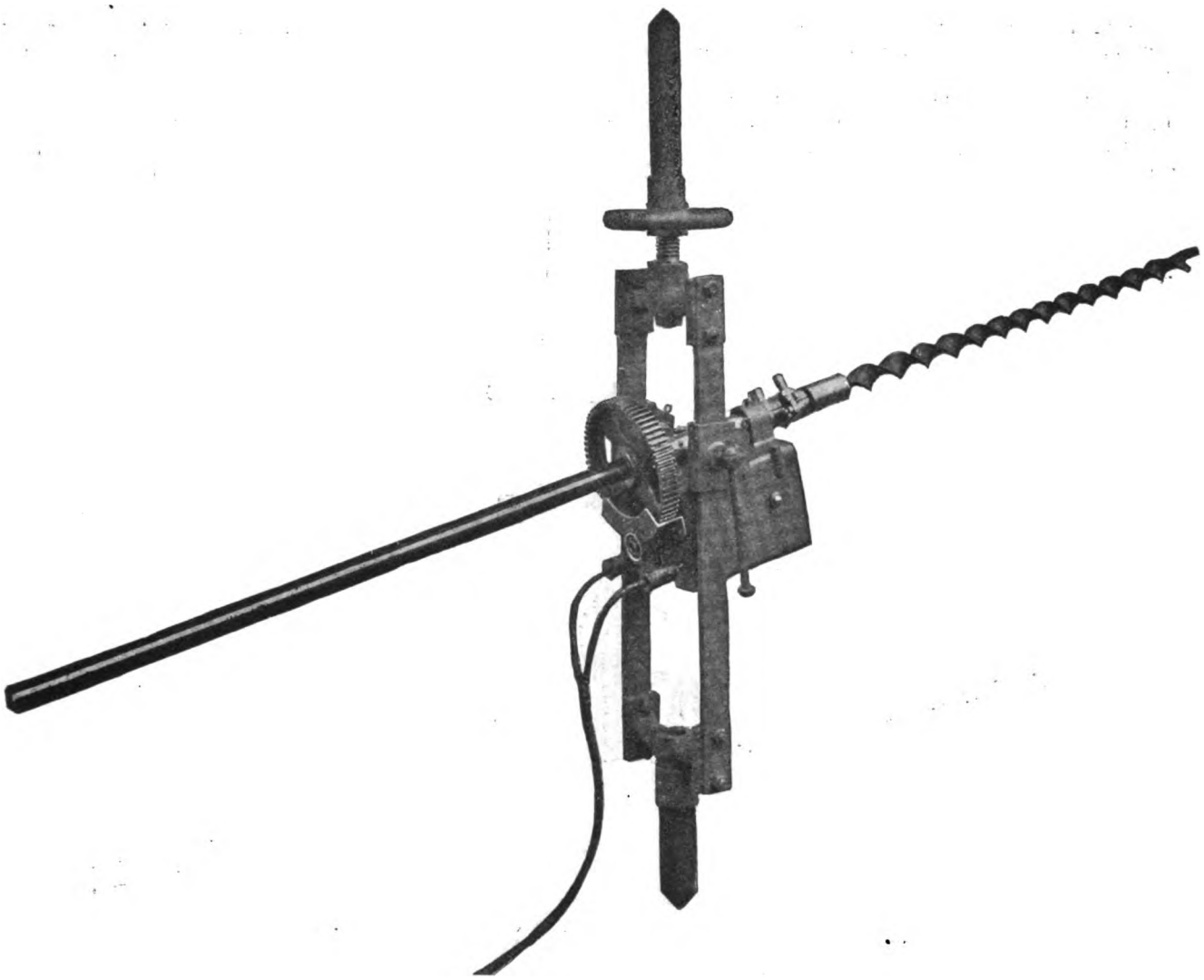
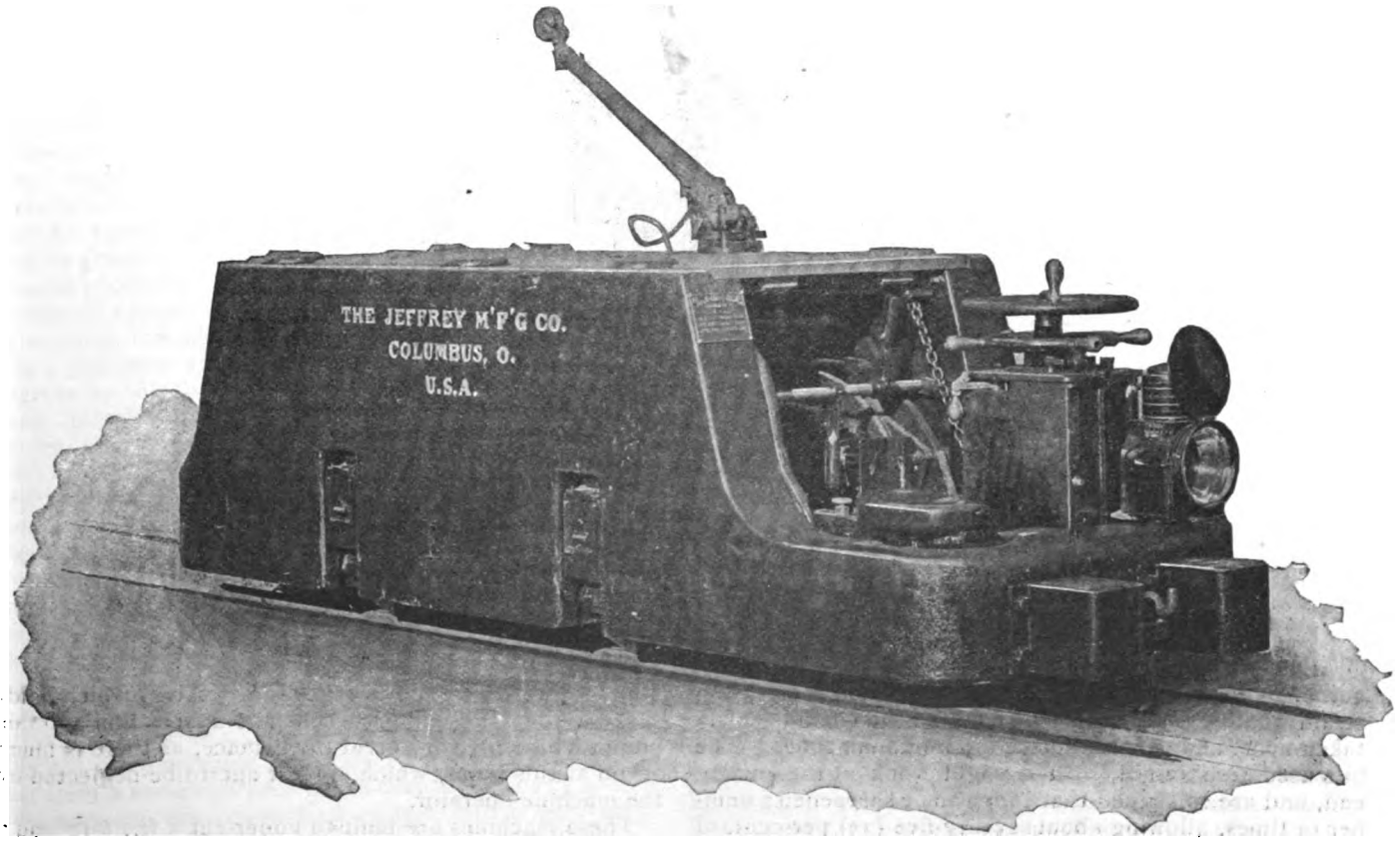


Jeffrey A 1 1-2 Electric Drill, Double Post. For use in bituminous fields.



Jeffrey Electric Locomotive. Man on End.

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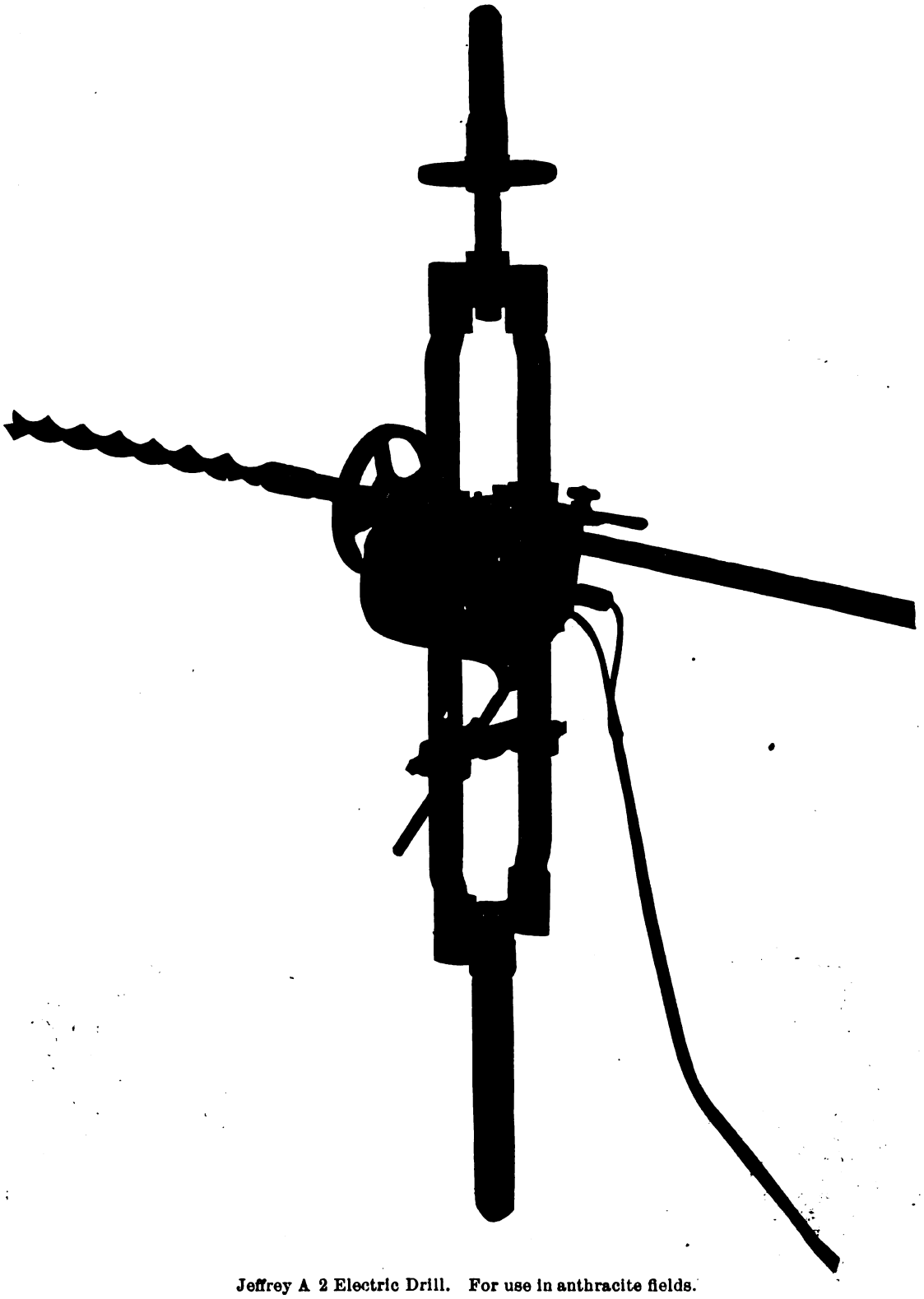
eral years and has thoroughly demonstrated its value. All the bearings are of bronze, no babbitt being used in any case.

The chain carrying the cutters is made up of cast steel solid links coupled together with drop-forged straps; these strap links having lugs at each end which provide bearings for the cutter links, the straps being held together by means of a rolled steel rivet, which receives no strain whatever. By this construction the chain is easily taken apart and can be replaced in minimum time. The bits used are straight, with a slight hook at the cutting end, and are so shaped that they can be sharpened a number of times, allowing about seventy-five (75) per cent. of the steel in each bit to be used.

Another marked change is in the cutter head; this has been widened to cut six (6) inches more than the former machine, making the total width of the cut forty-four (44) inches, with a kerf of four (4) inches. The cutter head is bolted together and can be easily and readily taken apart. At each corner of the cutter head is an idler on which the cutting chain runs. To provide for an ample supply of oil to the bearings of the idlers a double bearing is used, which allows space for packing, which holds the oil, thus providing a constant lubrication at this point. This is of very great importance, as there is much strain at this point, which is most apt to be neglected by the machine operator.

These machines are built to under-cut 5 ft., 6 ft. and 7 ft., the width of each cut being forty-four (44) inches, with a kerf of about four (4) inches.



Jeffrey A 2 Electric Drill. For use in anthracite fields.

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INVENTION DEPENDENT UPON SCIENTIFIC KNOWLEDGE.

Intuitive invention is the outcome of a mind peculiarly gifted. It is an inherent power from which springs a great idea, the crystallization of which may leave it impressed upon the world for untold ages. The dependence of inventive power upon scientific knowledge is largely admitted by all men of scientific eminence, yet, strange to say, originality dies in such, and invention pure and simple is left to those of a lesser education and inferior scientific knowledge. A mind possessing originality is quick to grasp at a suggestion and develop it so that it becomes of direct importance and practical utility. In the field of applied science, particularly that of electrical engineering, the power of invention is largely dependent upon a good scientific training. The stepping stones of progress in this particular field are the dynamo, telegraph, telephone, arc and incandescent lamp, primary battery, etc.

All of these have been more or less originated and in part perfected by men of considerable scientific ability. Combinations have been effected from which spring systems of electric lighting of great commercial importance. Viewed as a whole, these systems represent a higher plane of intellectual development, the application of reason based upon existing elements. This opens up a new phase of invention, which, in the field of applied electricity, is more apt to be met with. If it is the invention of a new combination it certainly merits as much approbation in its way as a simpler, better known, though possibly not more valuable departure. It becomes more evident from a review of such cases that invention of a high order may be the product of certain minds only after having passed through a course of severe scientific discipline. On the other hand, the inventive faculty is often discovered in those whose illiteracy and lack of intellectuality is very marked indeed.

As an example of inventive power due to the possession of high intellectual attainments combined with rare scientific ability we cite the case of Nikola Tesla; in opposition to him, Thomas A. Edison, in whom the inventive faculty has been strongly developed, but whose mental horizon is not so far-spread and wide-reaching as that of his younger confrere. Edison received little or no early training. He began life with severe trials confronting him, whereas Tesla had better opportunities and hence belongs to that class of inventors whose most notable successes were the fruits of a thorough scientific training. Thus by comparison side by side may be ranged inventors of repute, and it would be impossible to state among those best known which class preponderates, the inventor possessing many accomplishments or the one to whom arduous toil has been the only means of achieving success. It may be stated, however, that the civilized world is beginning to appreciate the fact that a higher education and higher training aids the mind to an extraordinary degree in many of the occupations of life. It quickens the mind to receive suggestions and cultivates in it the habit of thinking rationally.

In the "Journal of the Franklin Institute" may be found an article entitled "Science in the Public Schools," from which we quote: "Within less than a generation the scientific leaven has been working rapidly among educational authorities. The high school of today is equipped with apparatus and laboratories such as the best technical institute of thirty years ago did not possess. Facts unknown to the investigators of our childhood, discoveries unmade until a recent period, observations of a later date, help a lad who has a scientific turn of mind to develop his faculties. This improvement has in no small degree been brought about by the actions of scientific institutions."

To quote further: "Men who were fond of electricity or who liked to know what was being done at the great iron works or who wished to know something of the latest achievements in engineering could find congenial spirits at the Franklin Institute. Many a boy sent to its drawing school grew interested in the long shelves of books and in the apparatus which stimulated a desire to know more and more of the achievements of human industry. To consult a dozen volumes of Patent Office Reports or even to see half a hundred industrial publications is an experience to him who passes through it for the first time."

Scientific societies, as may be seen from the foregoing, exercise a great influence over the community and certainly assist in a large degree in hurrying along the tide of invention.

One of the great advantages of an American education is its acknowledgement of the commercial importance of scientific application and its readiness to make use of them on all occasions. In no section of the earth's surface is invention so greatly encouraged as in the United States. Many high-class inventions have appeared and an enormous number of small ones from New England. But to-day, as well as in the past, the greatest of them all have been the simplest ones, and their further elaboration has been entirely due to a better comprehension of the principle of operation, which, in comparison with the original thought, is of secondary importance.

Dallas, Tex.—The Sutton-Steele Electrical Co. has been incorporated by Walter L. Steele, Henry M. Sutton, Emmett A. Ellis and J. L. Sale. Capital stock, $20,000.

Worcester, Mass.—The People's Telephone and Telegraph Co. has been incorporated with Israel L. Currier, president; Fred W. White, treasurer. Capital stock, $150,000.

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All machinery built by this company is made from templets, and in case of accidents by fall of roof or other unusual circumstances any parts can be replaced without delay.

Considering the machine as a whole and in detail, it is an excellent piece of machinery, and one which will stand the inspection of the most critical mechanic.

The self-propelling truck, which is also illustrated with machine (both off and on), is a valuable addition to the machine where heavy grades are to be encountered and where pitching veins occur. With this truck it is possible to convert the machine into a locomotive and cause it to propel itself from point to point. By means of a reversing switch on the motor it is possible to run it in either direction. It will be observed that the motion is imparted to the truck wheels by means of a chain and sprocket. This method of propulsion is being used in mines pitching from 12 to 15 degrees. The truck itself is entirely of iron and is strongly and compactly built.

Since this machine has been in operation records of three hundred (300) lineal feet face, 5 ft. and 6 ft. deep, have been made in ten hours. The reduction in cost of repairs and the increased efficiency recommend it to the use of operators in need of such machinery.

The Jeffrey Manufacturing Company have always had the reputation of producing nothing but high-grade work, and in considering the bringing out of the machine (here described and illustrated) the question arose as to the wisdom of placing on the market a machine of cheaper construction, but realizing that by reducing the standard of construction and workmanship the life and efficiency of the machine would be decreased, they wisely made the decision not to lower the standard of excellence of their construction.

The advantages of an electric locomotive for mining purposes have been admitted by the largest mining establishments in the world. The high efficiency, cleanliness, convenience and freedom from risk by the use of electricity has made it indispensable in certain mining operations. The simple adaptation of mining machinery operated electrically to mining purposes has not in any way required a more extensive knowledge from the mining engineer. But in the general operation of mines the saving in different directions and the great convenience the use of electricity entails has made it a strongly competing factor with compressed air, steam, etc.

The electric mine locomotive made by the Jeffrey Manufacturing Company, built to carry, as shown in illustrations, a man in middle or at the end, is of unsurpassed design. A review of its good qualities would show that it is built in accordance with the requirements of practice. It is necessary to make the locomotives as compact and low as possible, to make them narrow, to obtain great hauling power with as high a speed as possible and to make them dust-proof and water-tight. The Jeffrey electric locomotive possesses all these features and represents all that a careful study of practical mining can give in the way of suggestions. The definiteness of action and flexibility of control exercised by the operator of an electric locomotive, as well as the freedom from fumes, heat, etc., certainly point strongly in favor of its general application.

The electric drills used mainly for coal mining manufactured by the Jeffrey people are preëminently successful on account of their simplicity and convenience. In the illustrations may be found types of the double post for use in the bituminous beds and the A2 for use in anthracite fields. These drills, as well as others that they manufacture, operated by air pressure have met with great success wherever installed. The types mentioned are auger drills. When electrically operated they merely consist of a drill driven by an electric motor. It is set into the vein and tilted to any angle to which it may be fixed by means of a supporting device.

Many of the largest mines in this country, to which the introduction of electricity has meant a direct increase in profit and a rise in the value of their stock, find that auger drills, locomotives, pumps, coal cutters, etc., electrically driven, are so superior to the more mechanical forms that a trial of them has usually resulted in their ultimate and complete adoption.

The drills referred to above are driven by a motor of the multipolar type. They are completely encased, with terminals accessible, armature and field coils thoroughly insulated and parts interchangeable. The standard electric drill does not weigh more than one hundred and fifty pounds complete. The angular range is sixty degrees from the horizontal and ninety degrees from the vertical. The feed bar is five and one-half inches in length. On one end of this is a socket to receive the auger. The feed nut is arranged in front of the drill and is supported by a drill. The nut is held in position by a collar, about which passes a steel spring friction band, which can be adjusted to allow the nut to turn with the auger at any pressure desired. This insures a release of strain on the drill when the auger strikes any hard substance, such as sulphur, hard slate or any other foreign material. This automatic stoppage of the feed prolongs the life of the drill and allows the machine to work under a uniform strain.

The economy of drilling as described above is such that from three to six hundred linear feet per day are bored. A man and a boy are all the aid required. The electric locomotives vary from ten to eighty horse power. Their minimum gauge is eighteen inches.

For further particulars correspond with the above concern at Columbus, O.

MISCELLANEOUS SCIENCE.

THE POWER NECESSARY TO MOVE THE EARTH.

La Nature, Paris.

Statisticians sometimes have queer ideas. One of them has amused himself by calculating how much energy, water and coal it would take to move the earth a foot, supposing that it was subjected throughout its mass to a force equivalent to terrestrial gravitation. This is a gratuitous supposition, for in spite of its enormous mass the earth weighs nothing, and it is only by piling up hypotheses that we can get an idea of Archimedes's famous lever. Starting with the fact that the earth's mass is about 6,100 million-million-million tons, our statistician calculates that we should require 70,000 million years for a 10,000 horse-power engine to move our globe a foot. The boiler that should feed this engine would vaporize a quantity of water that would cover the whole face of the globe with a layer three hundred feet deep. The vaporization of this water would require 4,000 million-million tons of coal. This coal, carried in cars holding ten tons each, and having a total length of thirty feet, would require four hundred million-million cars, which would reach 80,000,000 times around the earth. This train, moving at the rate of forty miles an hour, would take more than 5,000,000 years to traverse its own length. It would require for storage a shed that would cover a thousand times the area of Europe. If we realize that this fantastically huge amount of energy is as nothing at all compared with what the earth possesses in virtue of its rotation about its axis, its revolution about the sun, and its translation in space with the solar system, of which the earth is but an infinitesimal part and which is itself but an infinitesimal part of the universe, we may get some idea of the importance of man in the universe, and estimate his incommensurable pride at its just value.

Milledgeville, Ga.—J. G. Croley may be addressed concerning establishment of electric light plant.

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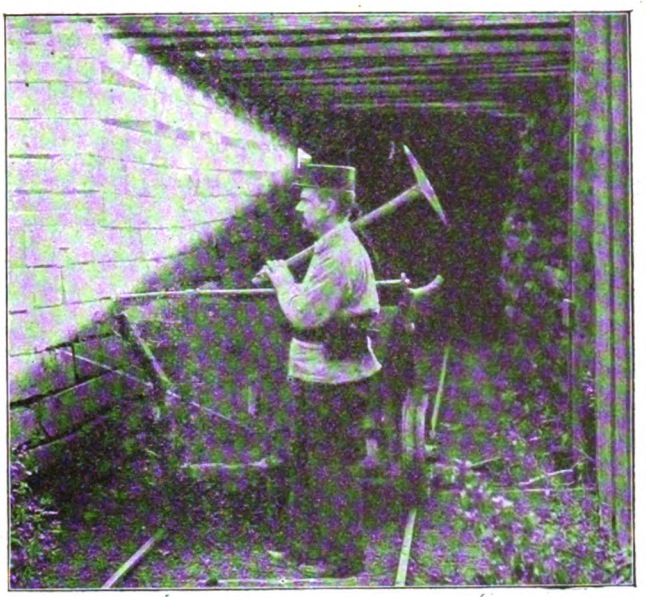
LIGHTING.

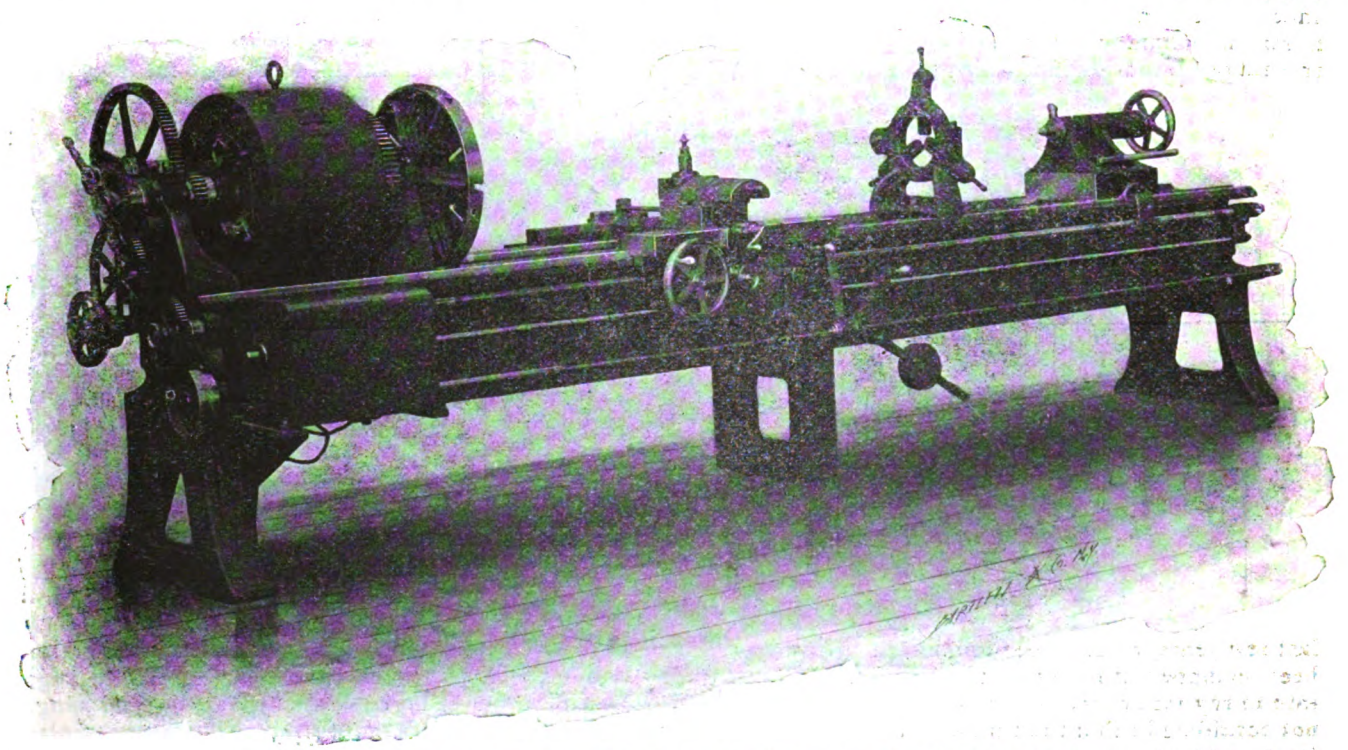
PORTABLE ELECTRIC SAFETY LAMP.

There has recently been devised a portable electric safety lamp for use in special cases when an open flame or even one safeguarded, as in the miner's lamp, would prove dangerous. The combination consists of a dry battery arranged to be carried in a holder at the belt, or in the pocket. The battery is controlled by a small rheostat, maintaining an even supply of current to the lamp and allowing it to burn with the same brilliancy during the life of the battery. Changing an exhausted for a new battery involves no electrical knowledge. The electric lamp, connected to the battery by a flexible cord, is the miners' lamp manufactured at the Edison Lamp Works of the General Electric Co. It is of six-candle power, and is set in a small white enameled parabolic reflector, provided with a stick-pin to allow it to be attached to the hat or any part of the clothing. The light is strong enough to allow ordinary printed matter to be read at a distance of 100 feet from the lamp.

The combination is manufactured by Elmer E. McIntyre, of Pittsburg, and has been found very useful by gas inspectors in reading meters in dark cellars; by repair men exploring cellars and trenches for gas leaks and defective pipe connections or examining gaseous sewers; by miners and mine inspectors in gaseous mines, where the risk of explosion even from the miner's lamp is ever present; by watchmen in powder mills and warehouses storing inflammable oils and essences, or by workmen repairing oil and gas tanks or examining the riveting inside steam boilers. This lamp is especially valuable as it leaves the hands free, and its weight is so small—about two pounds—as to be hardly noticeable.



Miners' Portable Electric Safety Lamp in use.



Bullock Type E Slow-speed Motor Built in the Headstock of a 22-inch Engine Lathe.

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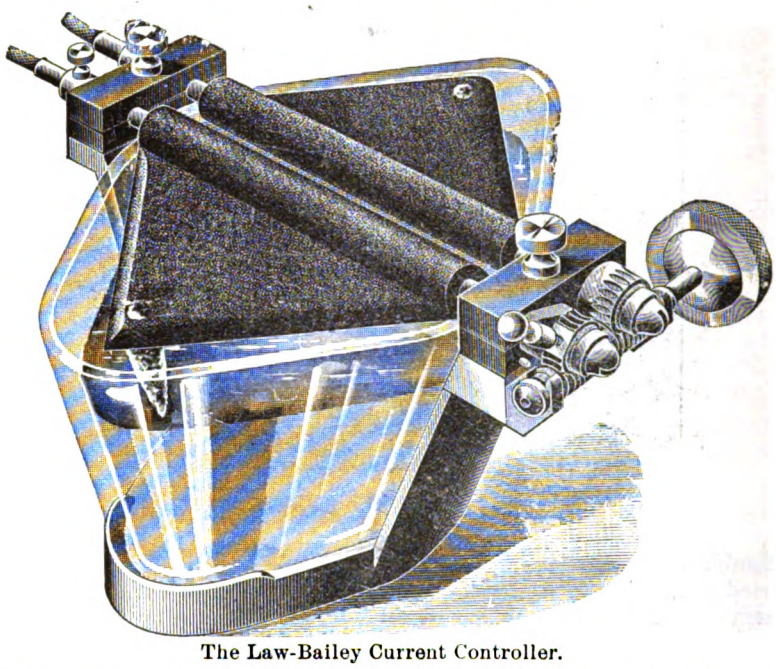
ELECTRIC LIGHT AND POWER.

BULLOCK POWER MOTORS.

There is a great change taking place in many of our modern factories and machine shops. It was only a few years ago that a shop that was lighted by electricity was considered to have taken a great step to the front. The use of electricity was recognized to be a saving, but it was only considered as a means of saving in the expense and convenience of lighting. Now the great use of electricity in factories is its employment as a driving power for all classes of machinery. The old method of drive, requiring long lines of shafting and innumerable belts, is gradually being supplanted by the use of wires and a few motors placed either on a counter-shaft or directly attached to the driving shaft of the machines. This advance of electricity in the machine shops and factories is still in its infancy, though even at present a large percentage of those shops which have been built in the last few years, or have been remodeled in any way, have been equipped with electricity. Within ten years it is safe to say that every factory or machine shop, which is not considered behind the times, will be using electricity for driving its tools.

The Bullock Electric Manufacturing Co. were one of the pioneers in this branch of the use of electricity and they have met with well merited success. The accompanying cut shows one of their motors direct-connected to a Niles Tool Works Lathe. This is one of many of these combinations which have been sent to factories in various parts of this country and England. The Bullock Company are at present putting motors in the headstock of three more of these lathes. Unless the lathe is 22 inches in swing or larger, it is not practical to put the motor directly in the headstock of the lathe, as the motor will be too large for the ordinary size of headstock. In case of 18-inch swing and under, the Bullock people have another arrangement. The lathe is taken as an example of machine tools driven by direct-connected motors, but the same has been done with other tools. The Bullock Electric Manufacturing Co. have successfully put motors on almost every style of machine tool.



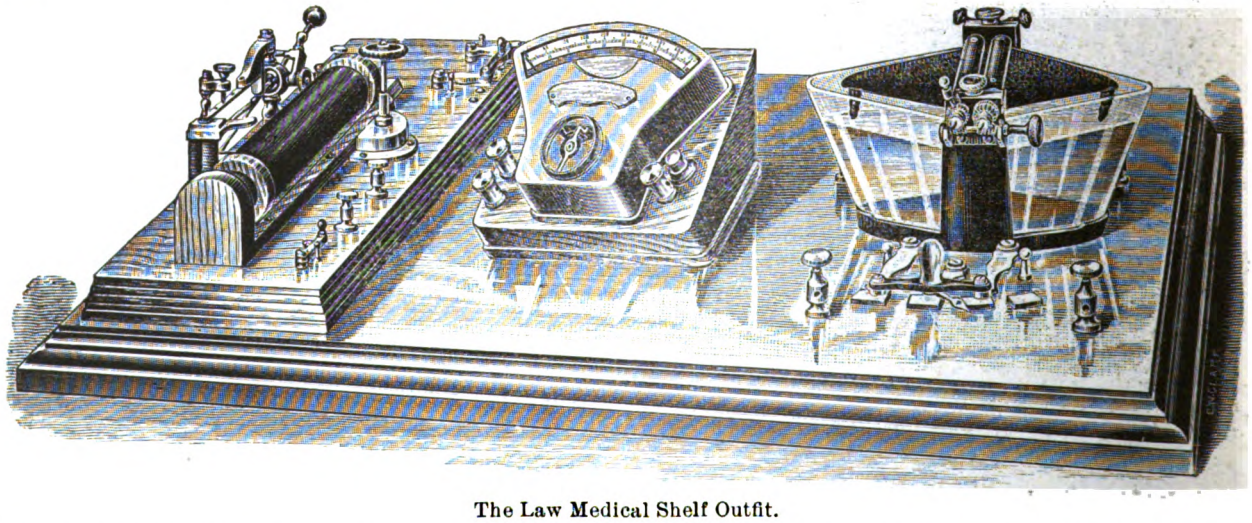
The Law-Bailey Current Controller.

ELECTRO-THERAPEUTICS.

MODERN ELECTRO-MEDICAL OUTFITS.

The advance in the field of electro-medical appliances has developed to such an extent that both battery man and instrument maker have been forced to supply the best that human ingenuity is capable of producing.

After years of careful study preparatory to placing in the electro-therapeutical field instruments the most efficient in quality and the most compact in structure, we are pleased to call the attention of the medical profession to the instruments herein enumerated, described and il-



The Law Medical Shelf Outfit.

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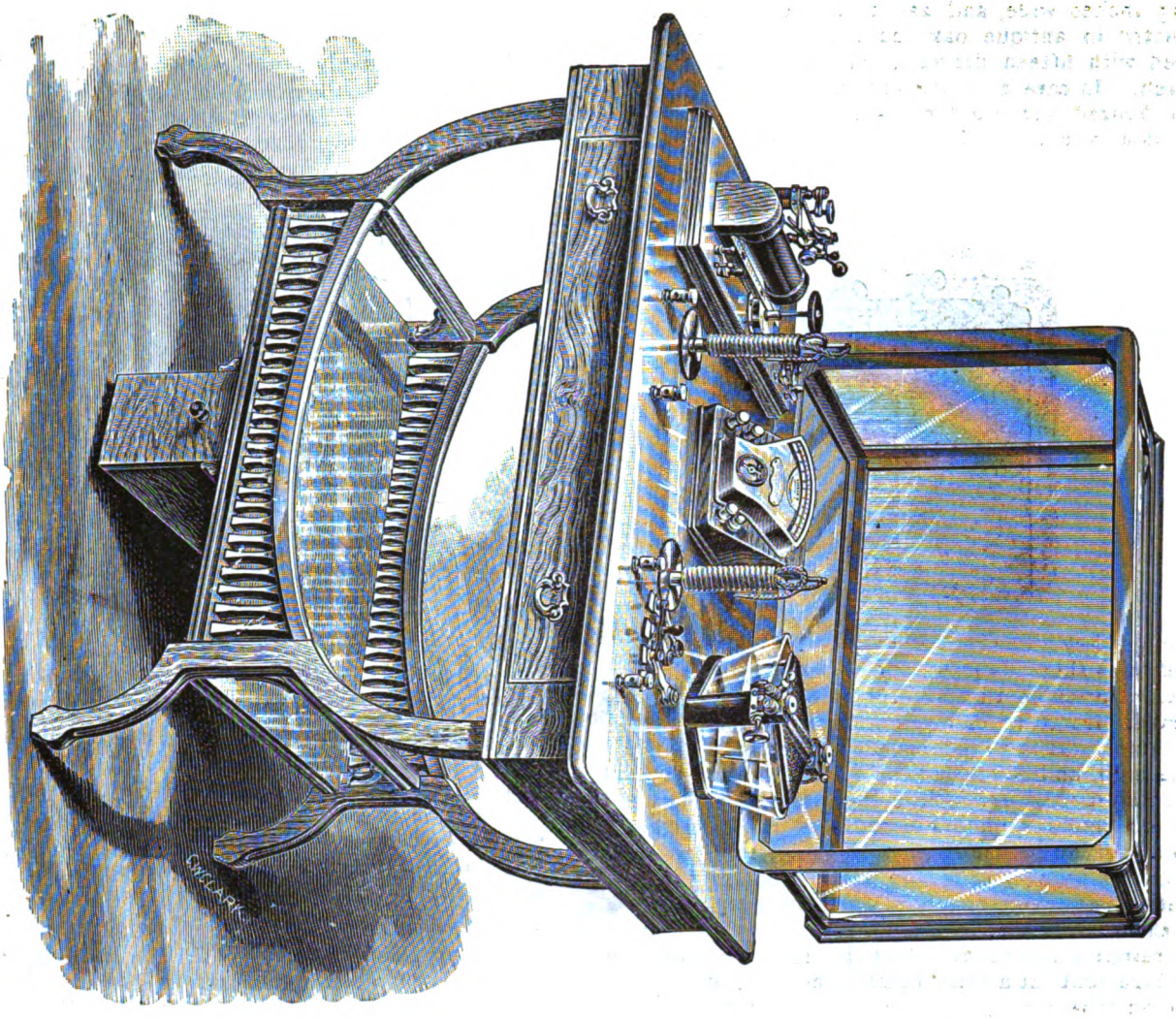
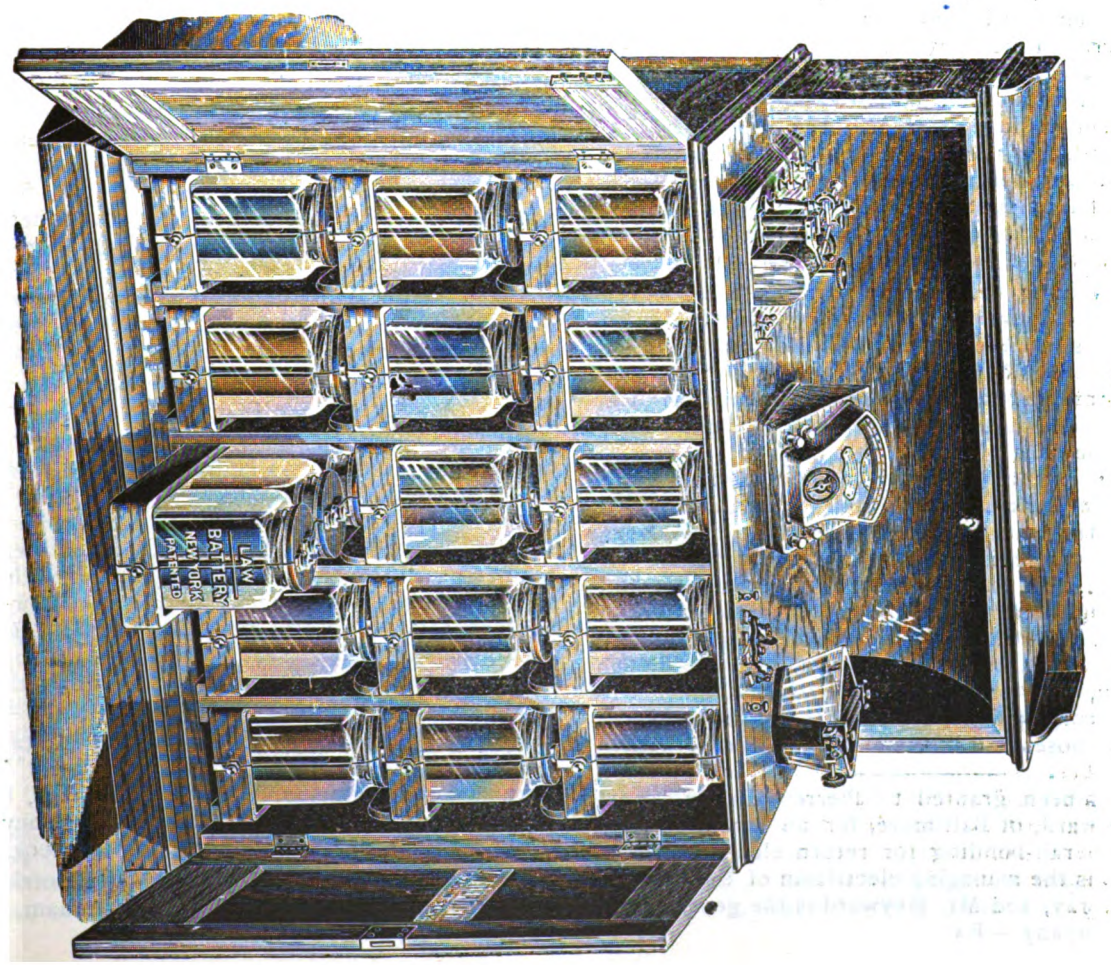


The Law Medical Table Outfit.



The Law Medical Cabinet Outfit.

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lustrated. This is the celebrated Law cabinet. It is 44 in. high, 23 inches wide, and 22 inches deep, and can be constructed in antique oak, mahogany or walnut. It is equipped with fifteen drawers, capable of holding four cells each. In case a longer-life battery with more volume is desired, the Gordon Battery Co. can substitute the Gordon primary cells, No. 2 size, for the Law cells.

Although they advocate, when means permit, the purchase of the cabinet in preference to the table, they are, however, pleased to call attention to the merits of this table outfit. It is 36 inches long, 22 inches wide, and 38 inches high, and is finished the same all over. It makes a splendid disposition of the instruments, and when the top is down and the doors closed it is in appearance like a desk. It can be equipped with either the Law cells or the Gordon primary cells, the latter reducing the cost of operation and maintenance, in a period of years, about 30 per cent.

The shelf outfit affords a ready means for disposing of the instruments at a small outlay, the cells, of course, requiring a separate and convenient place of deposit. It is made of antique oak or other hard wood, finely polished and finished, being 24 inches x 15½ inches in size, and is designed to rest on brackets against the wall or set upon a table. Either Law cells or Gordon primary cells can be furnished with this shelf outfit.

Although simple in appearance, the new Law-Bailey current controller is the result of six years' experiment with the old Bailey controller and six years' experiment with the new Bailey controller, and as a result it stands upon the market today without a peer. It is a perfect supplantation of the switchboard or cell selector as a means of modifying the current, turning it off and on steadily and gradually, thus preventing disagreeable and injurious shocks in all cases in which these regulations are essential.

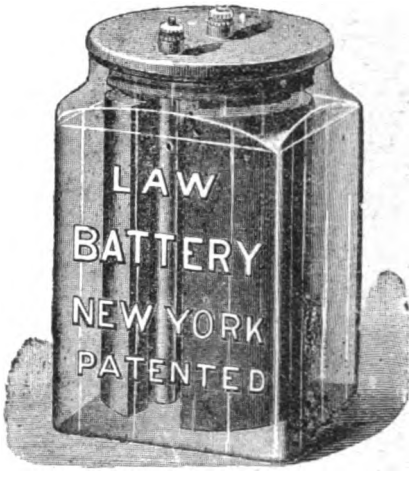
It is an instrument commendable for its simplicity, certainty of current graduation and equal distribution of wear among the cells.

The Gordon Battery Company have their offices at 594 Broadway, New York City, and factory at Cranford, N. J. The cells they manufacture possess to a high degree the following qualities: low internal resistance, uniformity of current, high electromotive force, non-corrodable connections and long life. The cell is clean and odorless, and the ampere hours are not affected by changes of temperature. The Gordon battery has found a wide field of application, not only among physicians, but with trunk railway corporations, electric gas-lighting concerns, telegraphic purposes and in the amateur's hands.

A patent has been granted to Pierre O. Kielholtz and James F. Heyward, of Baltimore, for an invention to locate defects in rail-bonding for return electric circuits. Mr. Kielholtz is the managing electrician of the City and Suburban Railway, and Mr. Heyward is the general manager of the company.—Ex.

STRAY CURRENTS.

The use of electric power generated by a turbine wheel for farm purposes is qnite well established in some parts of Germany and contains great possibilities for the future. The turbine wheel would not always be practicable, but the generation and distribution of electric power



on a large scale is all but a certainty. When it comes the farmer may be the greatest beneficiary of us all.—Ex.

The cyclist can now take a course of electric treatment on his wheel. A new handle-bar has been brought out which has metallic grips connected with a small generator mounted on one of the wheels. In another form of the same device shoes are provided with contact plates. If the force of the current depends upon the speed the wheels are rotating, this may be a satisfactory device to discourage scorching.—Ex.

It is understood, says an Indian newspaper, that the proposed scheme to obtain water power from the Sutlej to be transmitted electrically up the hill for use at the spring water pumping stations instead of steam, and also for electric lighting, is considered possible, but financially impracticable at present or in the near future.—Ex.

The passage through the St. Gothard tunnel is described by a recently returned traveller as having been something appalling during the recent hot season. With smoking locomotives burning briquette coal, the journey of 9¼ miles, which occupies about 20 minutes, is almost unbearable. The informant states that there is not far from the tunnel mouth a stream of fair size, which falls about 1,100 feet in a course of four miles by road, so that the water could easily be piped to Goeschenen, a distance of 2¾ miles by road from the Devil's Bridge, nearly 1,000 feet above Goeschenen, and utilized on Pelton wheels to work the tunnel by electricity.—Ex.

Mr. J. F. Kelly, of the Stanley Electric Mfg. Co., Pittsfield, Mass., has patented a device for preventing the leaking of lines of force from a dynamo or alternator into the engine coupled to it. The patent illustration shows an inductor type of alternator with a single coil. In this case the shaft is magnetized, and leakage lines tend to pass through the working parts up to the cylinders and bed plate, and hence back to the alternator frame. To prevent this Mr. Kelly proposes to use a second coil round the shaft near the coupling, and to so proportion the ampere turns in it that the magnetomotive force of the large coil is neutralized.—Ex.

North Tonawanda, N. Y.—Tonawanda Cataract Power Company has been incorporated by Edward D. Adams, Francis Lynde Stetson, Edward A. Weekes, William B. Rankine, Charles Sweet, L. A. Groat and Delancy Rankine; to supply light, heat and power. Capital stock, $100,000.

Little Rock, Ark.—South M'Allister Electric Light Co. has been incorporated with L. G. Graham, president. Capital stock, $25,000.

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Among the Societies

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The 128th Meeting of the Institute was held at 12 West 31st street, on Wednesday, October 26th, President Kennelly in the chair. A paper was read by Mr. A. A. Knudson on "An Electrical Survey in the Borough of Manhattan, New York City." The discussion was opened with a communication from William Maver, Jr., continued by Townsend Wolcott, Jesse M. Smith and others.

The president announced that a Committee on Co-operative Research had been appointed in accordance with instructions from Council. The committee consists of Dr. A. E. Kennelly, chairman; Prof. W. A. Anthony, Dr. F. B. Crocker, Dr. C. T. Hutchinson, Dr. Samuel Sheldon, Charles P. Steinmetz and Prof. E. Thomson. The purpose is to formulate a system of experimental research, by submitting to various colleges and universities various problems which are of practical importance. The committee starts off with a list of sixteen subjects and will expect members to send in others which may occur to them in the course of their practice. The results when received, if deemed important, will be published in the Transactions. The plan is receiving hearty support.

At the meeting of the Executive Committee in the afternoon the following Associate Members were elected:

John McL. Murphy, Electrical Engineer, Safety Third-Rail Electric Co., 5 Beekman street, Room 223, New York.

F. K. Vreeland, 2nd assis't engineer, Crocker-Wheeler Electric Co., residence, 228 Orange Road, Montclair, N. J.

J. E. Woodbridge, editor Electrical World, 9 Murray street, New York.

The following Associate Members were transferred to membership:

C. H. Wordingham, city electrical engineer, Manchester, England; William Stanley, electrical engineer and inventor, Pittsfield, Mass.

Business News.

NEW INCORPORATIONS.

Council Bluffs, Ia,—The Council Bluffs Gas & Electric Co. has been incorporated, with a capital stock of $250,000.

Chicago, Ill.—Electric Heat & Power Co. has been incorporated by Chas. B. Coffeen, Alvah S. Hopkins and Howard B. Cook. Capital stock, $5,000.

Peoria, Ill.—Diamond Meter Co. has been incorporated by E. H. Couch, W. E. Heyle, A. B. Fink and O. A. Scheefer; to manufacture electric meters and other appliances. Capital stock, $30,000.

Warsaw, Ind.—Warsaw Electric Co. has been incorporated by Noah J. Clodfelter, A. T. Spencer, Charles J. Lohman and J. C. Hamilton. Capital stock, $30.000.

Chicago, Ill.—Cass & Aaron Co. has been incorporated by Rush Spalsbury, J. Aaron and Philip Cass; to manufacture electrical machinery and supplies. Capital stock, $10,000.

Montezuma, Ga.—The Montezuma & Oglethorpe Light Company has been incorporated by Jule Felton, V. O. Brown and O. K. Brown; to operate electric and other lighting plant, etc. Capital stock, $3,000.

Dallas, Tex.—The Sutton-Steele Electrical Manufacturing Co. has been incorporated by Walter L. Steele, Henry M. Sutton and J. L. Sale; to manufacture electric fans, motors and other electrical supplies. Capital stock, $20,000.

Joplin, Mo.—The Joplin Illuminating Co. has been incorporated with John C. Porter, Harrison J. Drummond, John J. Dunham, Francis Kuhn and Charles Nelson. Capital stock, $80,000.

Waterbury, Conn.—Waterbury Battery Co. has been incorporated by C. Platt, Charles B. Schaumacht and C. M. Platt. Capital stock, $10,000.

Ayer, Mass.—Ayer Light and Power Co. has been incorporated with George A. Beatey, president; W. M. Sargent, treasurer. Capital stock, $50,000.

New York, N. Y.—The Edison Junior Electric Light and Power Co. has been incorporated by Thomas A. Edison, Jr., S. R. Valentine Robinson, H. C. Hepburn, E. A. Drake, C. S. Henry, R. M. Jordan, J. G. Batterson, Jr. and F. J. Stone. Capital stock, $500,000.

TELEPHONE CALLS.

Carleton, Mich.—The People's Telephone Co., of Wayne and Monroe Counties, held annual meeting recently, and issued a dividend of 10 per cent. to stockholders and elected the following officers: Joseph Waltz, President: F. L. Edward, Secretary; W. S. Morey, Treasurer.

Kenton, Ohio.—Kenton Telephone Co. has been incorporated; to operate a telephone system to Marysville, Bellefontaine, Wapakonita and Lima. Capital stock, $30,000.

Middleburg, Va.—E. B. Milhollen has closed a contract to construct a telephone line from Middleburg to Plains.

Paducah, Ky.—The city has sold to the highest bidders two telephone franchises. One was bought by the Kentucky Electric Co. for $100. The American Telephone Co. bought the other. The company operating the present system did not bid.

New York, N. Y.—Fowler Switchboard and Telephone Co. has been incorporated by John T. McRay, Samuel B. Fowler and L. Victor Heckles; to manufacture telephone and other electrical fixtures. Capital stock, $5,000.

New Philadelphia, Ohio—Tuscarawas Home Telephone Co. has been incorporated by James S. Bailey, Jr., Frank W. Bainbridge, John W. Yeagley, O. S. Welty and J. H. Mitchell. Capital stock, $75,000.

Summerville, Pa.—The Summerville Telephone Co. will extend its line to Big Run and Eleanora.

Dickson, Tenn.—A telephone line will be constructed from Dickson to Charlotte.

Oakland, Cal.—Oakland Messenger, Burglar and Fire Alarm Company has been incorporated by Albert Aucker, Henry H. Beck, Frederick Kahn, Philip Marx, Edward I. Wolf; to build and operate telephone and telegraph lines, conduct a general messenger business, etc. Capital stock, $20,000.

Lexington, N. C.—The Lexington Telephone Co. has let contract for the extension of its line from Lexington to Salisbury.

Prairie, Ind.—Prairie Telephone Co. has been incorporated with a capital stock of $10,000.

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STREET RAILWAY NEWS.

Detroit, Mich.—The Detroit & Pontiac electric road will be extended to Owosso.

Pittsburg, Pa.—The Braddock Electric Railway Co.; A. L. Sailor and William M. Brown appointed receivers.

Beaumont, Tex.—John C. Ward and others have been granted a fifty-year franchise for an electric railroad.

Fort Smith, Ark.—Fort Smith Traction, Light and Power Co. has been incorporated, with Samuel McLeod President. Capital stock, $200,000.

Corunna, Mich.—An electric railway will be constructed between Pontiac and Owosso.

Agawam, Mass.—An electric railway will probably be constructed from Agawam to West Springfield.

Dayton, Ohio.—Dayton & Eastern Traction Co. has been incorporated by Henry B. Pruden, George E. Wright, H. O. Cox, Williams A. Mays and W. S. McConnaughey; to operate an interurban electric railway. Capital stock, $10,000.

Columbus, Ohio.—Dayton & Xenia Traction Co. has been incorporated by J. M. Wilson, O. O. Ozias, F. D. Bittinger, Isaac G. Kennedy and Philip A. Kemper; to operate an electric railway. Capital stock, $300,000.

POSSIBLE INSTALLATIONS.

Key West, Fla.—J. L. Watrous has asked for franchise to construct and operate street railway power plant, electric lighting plant, telephone system, etc.

Suffolk, Va.—David Reckard has established works for the manufacture of dynamos and other electrical appliances.

Harpers Ferry, W. Va.—The Harpers Ferry Light & Power Co. has obtained franchise for establishment of an electric lighting plant.

Fredericksburg, Va.—The Mayor may be addressed concerning proposed electric light plant.

Richmond, Va.—The Richmond Paper Manufacturing Co. has contracted for the installation of an electric light plant.

Forsyth, Ga.—W. A. Pye, City Clerk, may give information concerning proposed purchase of electric light plant.

BUSINESS CHANCES.

Ansonia, Conn.—The E. A. Perkins Electrical Co. has increased its capital stock from $5,000 to $20,000.

Chicago, Ill.—H. & J. M. Hirsh, electrical manufacturers, gave chattel mortgage for $500.

Madison, Wis.—The People's Electric Co., electrical supplies, has made an assignment. Liabilities, $3,500; assets, same.

NEW YORK ITEMS.

MR. C. O. BAKER, JR., of Baker & Co., platinum refiners, Newark and New York, has returned from Europe after an enjoyable trip.

J. R. VANDYCK, manager of the American Impulse Wheel Co., 120 Liberty street, has just returned from an extended business trip. Mr. Vandyck secured a number of large orders while away and appears to be well satisfied with the business outlook.

WILLIAM A. ROSENBAUM, the well-known patent lawyer and expert, Times Building, will deliver a lecture on "The Status of Electrical Invention," before the Electrical Section of the Franklin Institute, of Philadelphia, on November 8.

THE NATIONAL CONDUIT AND CABLE COMPANY, Times Building, has been awarded the contract for the underground construction of the lines of the Third Avenue Railroad Company. The amount of the contract is $1,500,000.00.

THE MURPHY SWITCHBOARD COMPANY have opened up offices at No. 30 Cortlandt street. The company is under the management of the well-known switchboard manufacturer, Mr. T. J. Murphy, and will find no difficulty in keeping to the front under his able guidance. They manufacture all kinds of switch and panel boards and guarantee to give perfect satisfaction.

MR. GEO. H. BERG, of Geo. H. Berg & Co., 50 Bromfield street, Boston, Mass., general agents for Tirrell Potential Regulator, was in town a short time ago. A representative of The Electrical Age noticed Mr. Berg installing one of the above regulators in the Lords' Court Building, 27 William street. Mr. Berg states that the regulators are giving perfect satisfaction and are meeting with great success among electrical engineers.

The "Review of the River Plate" says: "Buenos Ayres, S. A.—The tricks of the electric light wiremen (as they are pleased to call themselves) in this city are numerous. We have heard of one who did not believe in prepared tape for covering the joints, but made his own by dipping bits of old rag in paraffine. Another excused himself, when it was discovered that half the joints were not soldered, on the plea that he had not had time; but he had found enough time to cover over all the joints with tape, and he waxed wroth when an engineer told him what he thought of him and his work. The excuses made for low insulation are numerous and varied, but no wireman has yet acknowledged that this is due to scamped work. There is such a boom in electric light work now that everybody is going into the business, but many will retire with burnt fingers and dearly bought experience."

WESTON STANDARD

PORTABLE DIRECT READING

VOLTMETERS AND WATTMETERS

For Alternating and Direct Current Circuits.

The only standard portable instrument of the type deserving this name.

Write for Circulars and Price Lists 8 and 9.

WESTON ELECTRICAL INSTRUMENT CO.

114-120 WILLIAM STREET, NEWARK, N. J.

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The Electrical Age.

VOL. XXII—NO. 20 NEW YORK, NOVEMBER 12, 1898 WHOLE NO. 600

HEADLIGHT FOR ELECTRIC CARS.

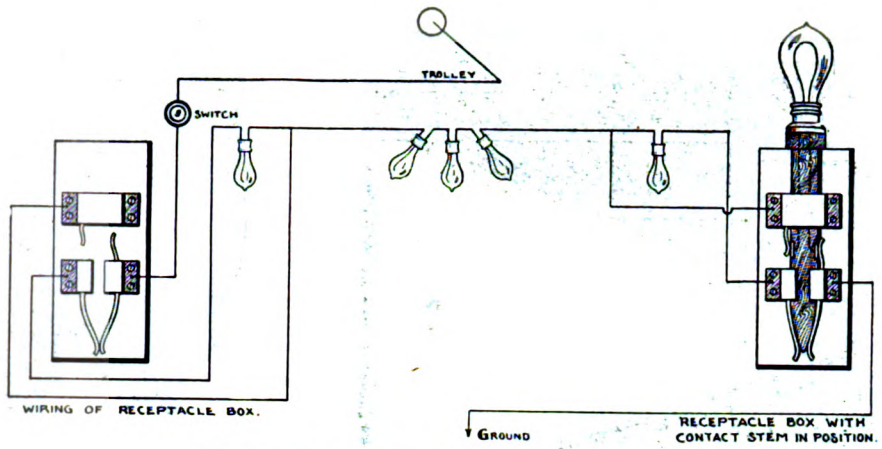
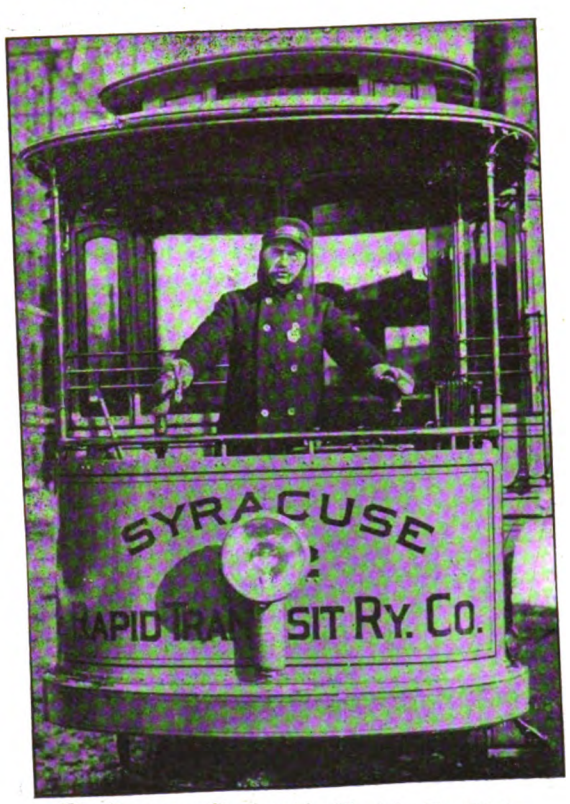


Diagram of Connections for a Five-Light Car.

The above Illustration shows the Motorman ready to make the change from one end of the Car to the other.



The Syracuse Changeable Electric Headlight.

THE SYRACUSE CHANGEABLE ELECTRIC HEADLIGHT.

The use of headlights on cars that throw a strong, bright light, and whose attachment to the car is readily performed, has been long felt by street railway corporations. The changeable headlight herein described is constructed with a twelve-in. true parabola reflector of ninety-nine per cent. pure aluminum, highly polished. This reflector, encased in a steel jacket to protect it from injury, throws the light forward without waste or refraction. In front of the parabolic reflector is set a circular glass of double thickness in a solid brass rim, nickel plated. The glass front, twelve inches in diameter, is ably supported by a brass hinge and catch. The steel jacket has attached to it a contact stem made of second-growth hickory waterproofed by boiling in paraffine. At the top of the contact stem a lamp socket is firmly placed. To the top of the steel jacket a sheet steel handle is attached.

The Crouse-Hinds Electric Co., of Syracuse, N. Y., make two cast iron receptacles, one to be placed on each end of the car. These receptacles are only 10 inches high by 4 inches wide, and are hardly noticeable on the dash of the car, as you may see by referring to the illustration. In the top of these receptacles is a small square hole, just the size of the contact stem on the headlight. A little hinged cover is provided to keep out the water when the lamp is not in position. The contact stem has brass contact plates set in it, with wires running from these plates through the centre of the stem to the lamp socket at the top. Inside the receptacles are brass spring connections. Both receptacles are con-

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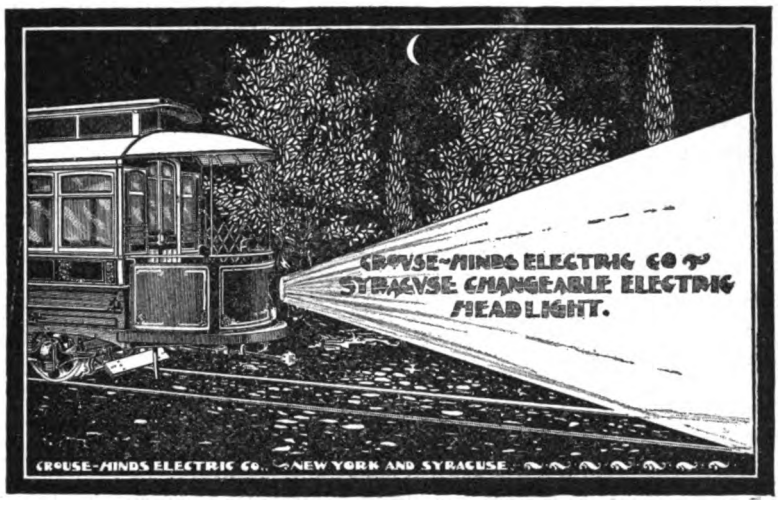
nected with the light circuit of the car. Push the contact stem into the receptacle at either end of the car, and the brass spring connections in the receptacle both hold the headlight firmly in place and complete the circuit, lighting the lamp in the headlight.

The headlight is automatic in action.

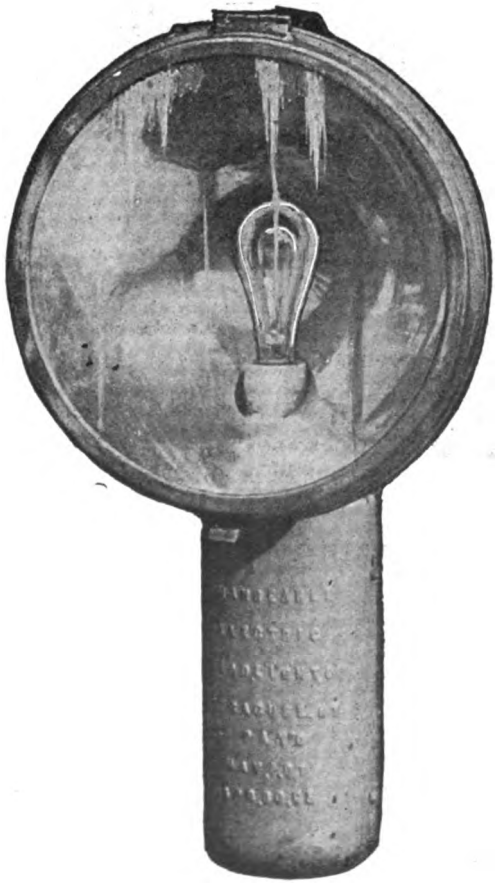


Seowing Reflector when Lighted.

No switch is necessary; simply putting in position lights the lamp.

It can be connected as an additional light, or it can be wired to automatically cut out the corresponding light in the car.

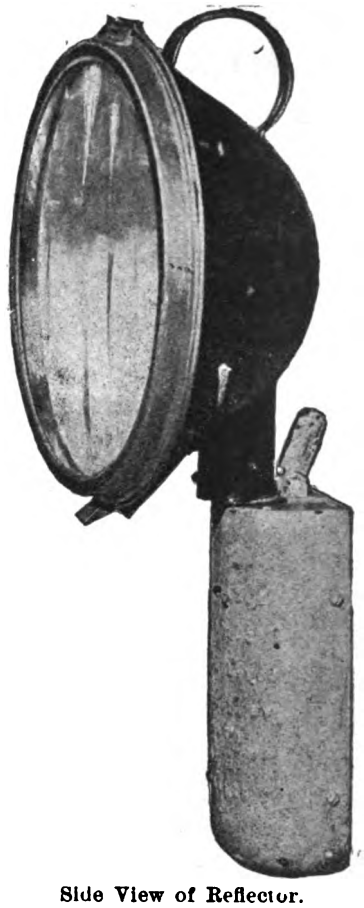
As the headlight projects only seven inches from the dash, it can be left in the receptacle during the day without fear of injury.



Front View of Reflector.

The receptacle for headlight on dash is light, strong, compact and neat, and never in the way.

The wires from the receptacle are run in a neat gas pipe with elbow just inside the dash, where they are protected from injury. Wires long enough to reach through the gas pipe and platform without joint are furnished with each headlight.



Side View of Reflector.

The gas pipe is bolted to the dash at the top and let into the sill at the bottom, making a solid and permanent job.

Lamp socket of any make desired will be furnished with headlight.

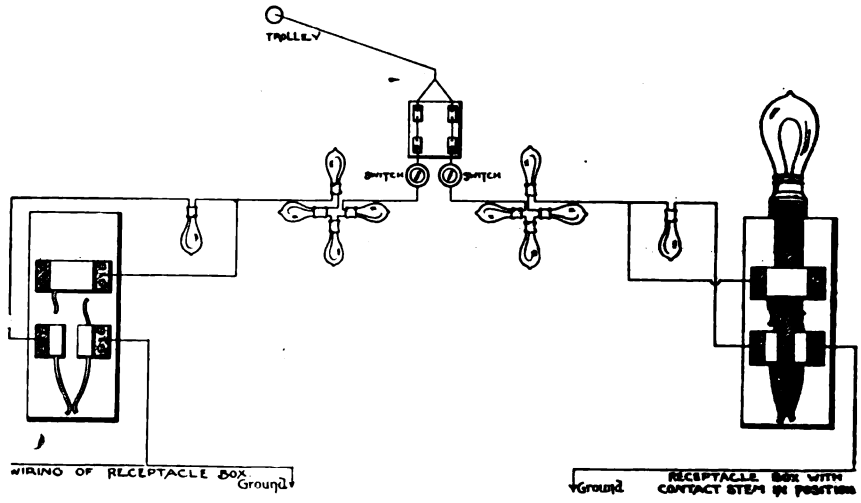


Diagram of Connections for a Ten-Light Car.

They guarantee that you can equip a line with their headlight for less money than with any other headlight that can be purchased. This can be understood when by realizing that only one changeable headlight, instead of two, is necessary for each car, and also take into consideration the fact that a corporation can equip all their cars at the same cost that would be required to equip either open or closed cars alone with any other make of headlight. This can be done by purchasing extra receptacles, which they furnish at a very small cost.

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The Crouse-Hinds Co. show that the purchaser cannot afford to use oil headlights for electric cars. The cost of maintaining an oil headlight for an electric car is, at a low estimate, as follows:

Oil, one day	$ .02½
Chimneys and wicks one day	.00½
Cleaning, filling and care, one day	.03
Total, one day	$ .06
For 365 days	$ 21.90

To say nothing of repairs, leaky tanks, bad odor, blowing out in the wind, and reflectors dimmed and ruined by oil.

It will be seen from the above that the cost of maintaining an oil lamp for a year is about twice the first cost of electric headlight, which pays for itself the first six months.

The Crouse-Hinds Company have had almost phenomenal success with this headlight, and have been running their factory night and day on them for the past three or four months. They claim to have the best and at the same time the cheapest headlight on the market today, and have made it a policy to send these lamps out on trial free of charge, paying the transportation charges both ways.

They have found in their experience of three years that they do not get more than one lamp in fifty back, and in most every case a sample lamp brings more orders for the goods.

Mr. F. M. Hawkins, Havemeyer Building, 23 Dey street, New York City, is the New York agent for the Crouse-Hinds Electric Company, and carries a large stock of the various styles of the "Syracuse" changeable electric headlight.

Burlington, N. J.—Rivershore Telegraph Co. has been incorporated by Nathan Haines, J. Howard Pugh, George C. Gunn, Mitchell B. Perkins and Henry V. Massey; telegraph and telephone business. Capital stock, $15,000.

Cleveland, Ohio.—Sands' Electric Co. has been incorporated; to deal in electrical apparatus. Capital stock, $10,000.

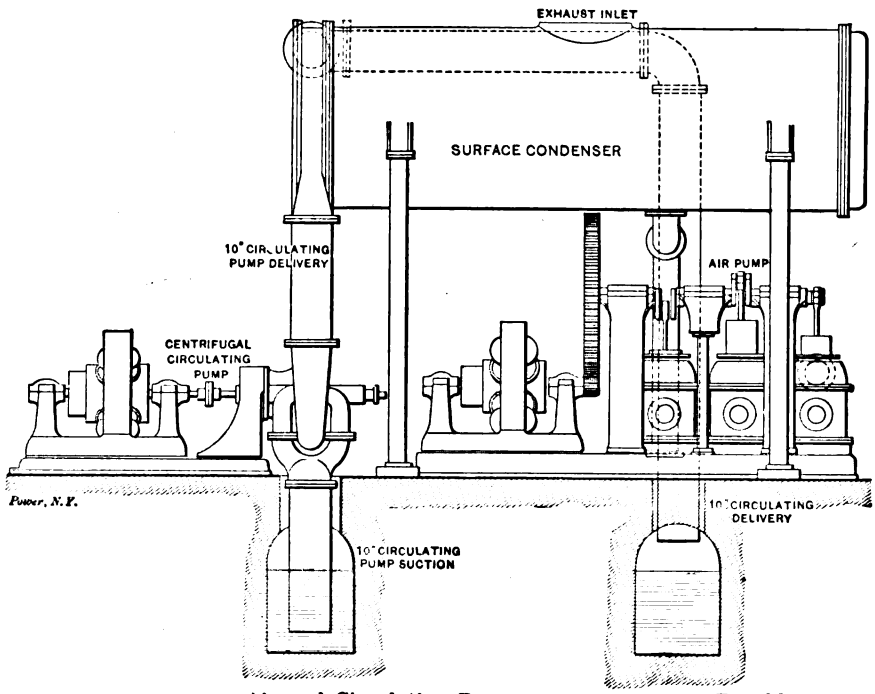
Corsicana, Tex. — The Southwestern Telegraph and Telephone Co. is expending over $50,000 in the improvement of its plant.

ELECTRIC LIGHT AND POWER.

THREE THOUSAND HORSE POWER DIRECT-DRIVEN STEAM DYNAMO AT THE STATION OF THE EDISON COMPANY, BROOKLYN, N. Y.

Through the courtesy of "Power."

Our illustration is a view of one of the large direct-driven steam dynamos in the new 66th street station of the Edison Electric Illuminating Company, of Brooklyn, N. Y. The dynamo was described in our issue (Power) of November, 1897; it is a 40-pole, 2,000-kilowatt, 75 revolution, alternating-current machine, with outside stationary armature and a revolving field. It was furnished by the General Electric Co. The field is mounted upon the shaft of a double horizontal tandem compound side-crank condensing engine, made by McIntosh, Seymour & Co. The engine has two 24-inch high-pressure cylinders and two 48-inch low-pressure cylinders, all of 60-inch stroke. The general arrangement of engine and dynamos is shown by the plan and elevation on page 3.



n Air and Circulating Pumps, Edison Station, Brooklyn.

It will be seen that the dynamo is placed between the two sides of the engine, and that the cranks of the latter are set at 90 degrees. The dynamo is so arranged that the outside armature may be moved along the shaft, allowing access to the field, which is on the engine shaft, and to the armature winding. The engine is rated at 3,108 horse power at 75 revolutions, ¼ cut-off, 165 pounds' steam pressure and 26 inches of vacuum. Both the dynamo and the engine are built for a considerable overload, the indicated horse power of the latter being 5,000 at a cut-off of 6-10.

Many of the details of the engine are deserving of special mention; some of them are shown in the outline drawings on page 2.

The shaft is of solid forged steel, 24 inches in diameter in the bearings and 27 inches in the generator fields; it weighs 28 tons. The other portions of the engine are correspondingly large; the main bearings, of which there are two, are each 24 × 42 inches, giving a total bearing surface of 2,016 square inches. The total weight on the two bearings is about 280,000 pounds, giving a pressure of about 140 pounds per square inch of projected diameter. They are provided with removable shells and water jackets. The crank disk is 8 feet 4 inches in diameter,

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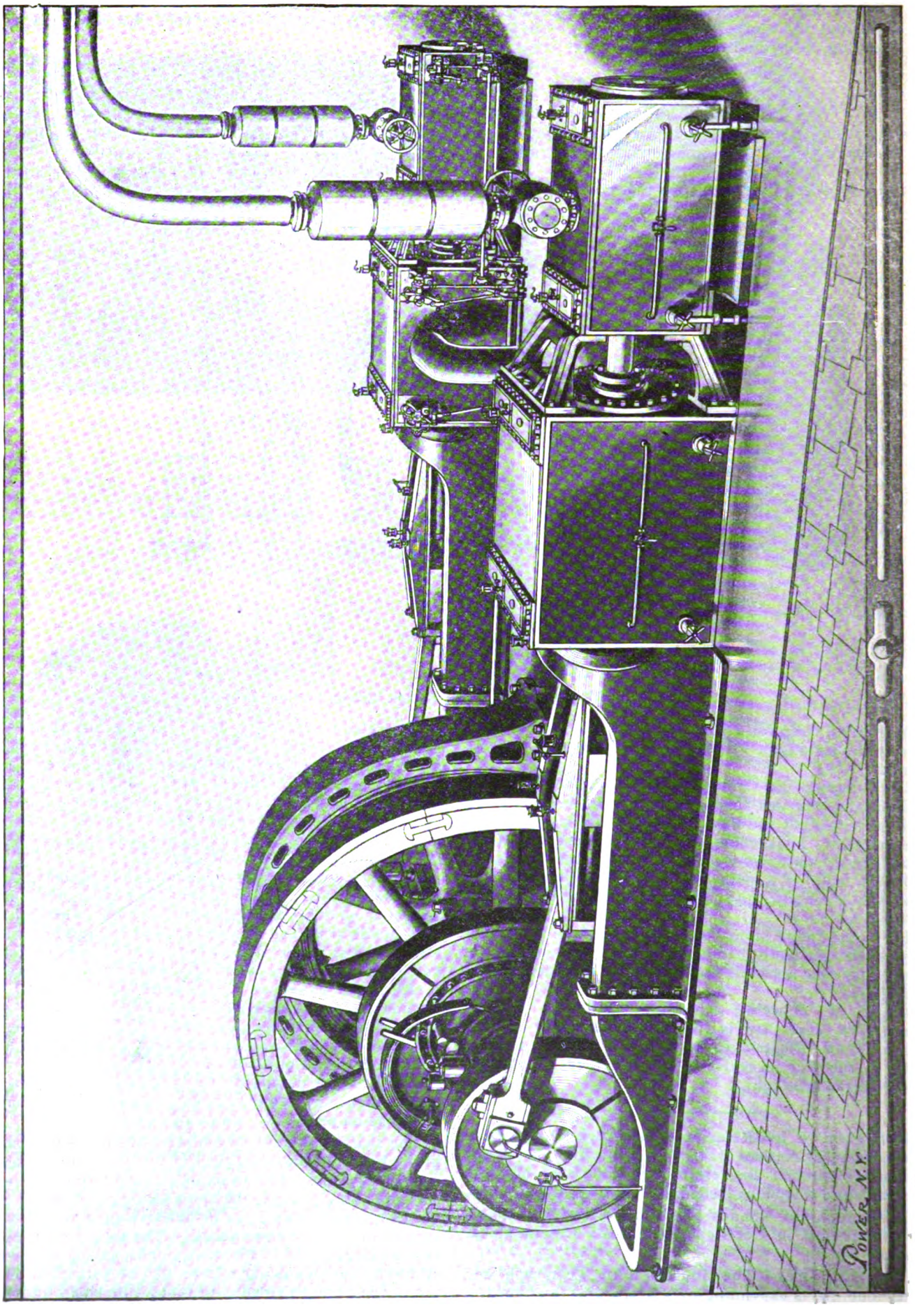
and the crank pins are 13 inches in diameter and 11 inches long. The cross-head pins are 11½ inches in diameter by 11 inches long, and the bearing surface of the cross head is 19 × 38 inches.

The fly wheel is large and heavy, being 24 feet in diameter and weighing 82½ tons, or about 53 pounds per



Three Thousand Horse Power Direct Driven Steam Dynamo, at Edison Station, Brooklyn, N. Y.

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WHAT CONSTITUTES A GOOD STREET RAILWAY SYSTEM.

The choice of electric roads is rather comprehensive on the part of heavy investors. The hour is ripe for a departure bringing with it benefits that appeal to the public as well as the stockholder. From a general standpoint, it cannot be said that a transformation has been effected in the field of street railway work of a character decidedly unique. Were the Brooklyn Heights Railroad Company to remodel their road to such an extent that it would become a huge automatic block system, sectional third-rail system, or any other of that particular nature, this, as an advance, would be decidedly sudden; but, instead, the open conduit has become the system marking the second step forward in the field of street railway work. The grand divisions could be called the trolley, the open-conduit, the automatic-block and the third-rail system. All sorts of combinations have been made, composed of these four elements, but so far the simplest and least scientific has found favor in the eyes of the holder of money bags. It is evident, however, that the second step forward, the building of an open-conduit road, has prepared the way for that system which will inevitably follow, the automatic system.

Thousands of inventors have been laboring at this idea for the last twenty years, and some few have largely succeeded in solving this great problem. Were the conduits of New York to fill frequently with water, the demand for a change would be most emphatic, but their perfect drainage has shown that in this respect the practicability of that system is established. The question is not one relating to the waste of power in the system, but to the first cost of installation to a much greater degree. If an automatic system was less expensive to install and operated with about the same degree of efficiency, in spite of its automaticity it would be well received and adopted in our larger cities.

The unsettled condition of the art in thi espect has led to considerable debate in street railway circles, but the obstinacy that once prevailed therein, opposing innovations of any description, has been swept aside and there is so great a reaction that this fraternity represents one of the most active and progressive in the world. They are quick to take advantage of little inventions, and, as far as greater changes are concerned, would be only too happy to see the installation on all sides of a generally acceptable system, superior to the primitive one now in use.

When this mooted question has been definitely settled, tremendous interests affecting our great trunk lines will become involved, and the new generation will be whirled from the Atlantic to the Pacific by a course whose advent has already wrought marvelous changes in the economy and relation of civilized powers.

THE USE OF ELECTRICITY IN THEATRES.

With the prospect of a busy season in theatrical circles and the immediate possibility of grand opera becoming a popular topic, the stage manager, or, rather, the business manager, of our most prominent theatres turns his attention to the heating, lighting and ventilating of the institution in his care. From a hygienic standpoint, electricity in the theatre is a permanent factor, by the utilization of which pure air, clear light and a grateful warmth is diffused. It seems that our English friends at the Savoy Theatre, London, first undertook to light this establishment by electricity. Mr. D'Oyley Carte, aided by the efforts of Messrs. Siemens Brothers, the distinguished electrical engineers, succeeded in demonstrating in a most practical manner that electric lighting in theatres was an accomplished fact.

Today the theatres of Greater New York make use of the electric current as an indispensable adjunct of their work. The entrance of the kinetoscope, cinematograph and other varieties of the same instrument have made the hand and automatic-feed focussing lamp a welcome addition to theatrical purposes. In fact, the name of the stage electrician is regularly inscribed on the programme, as much of the success and smoothness with which a play runs on depends upon the efficiency and ready ability of the stage electrician. The interest pertaining to his occupation grows when his aid is required in creating the magic effects viewed by an entranced audience at the grand opera. To us to whom the illusion is complete the details connected with success are comparatively unknown. The stage electrician, as it were, carries them up his sleeve, but with the appearance of a great Wagnerian exponent or a disciple famous in the field of drama, magnificent illusions are produced which aid wonderfully the art of the singer or actor. Perfection in this respect may be so reached that it becomes an art that hides the art.

The "Tempest" of Shakespeare and the great scenes produced in the operas of Wagner, Franchetti and Verdi require the closest study and attention on the part of the stage electrician. The throwing and blending of light at the proper moment, the gradations required for the successful imitation of sunrise and sunset, and various other adaptations to Nature certainly call for more intelligence than that required for the mere manipulation of switches. The duties of the stage electrician are frequently composed of others relating to the ventilation, heating and lighting of the theatre.

The enclosed arc lamp has found a foothold in its most modern form, electric radiators controlled to give any degree of heat are in vogue, and small electric fans or possibly great exhausts supply sufficient comfort and convenience to the theatre-goer to make his three-hour visit a matter of complete enjoyment. If modern science supplies fresh air, warmth, good light and part of the stage effects, the responsibility is thereby greatly lessened of making a play successful which rests entirely with those occupying the stage itself.

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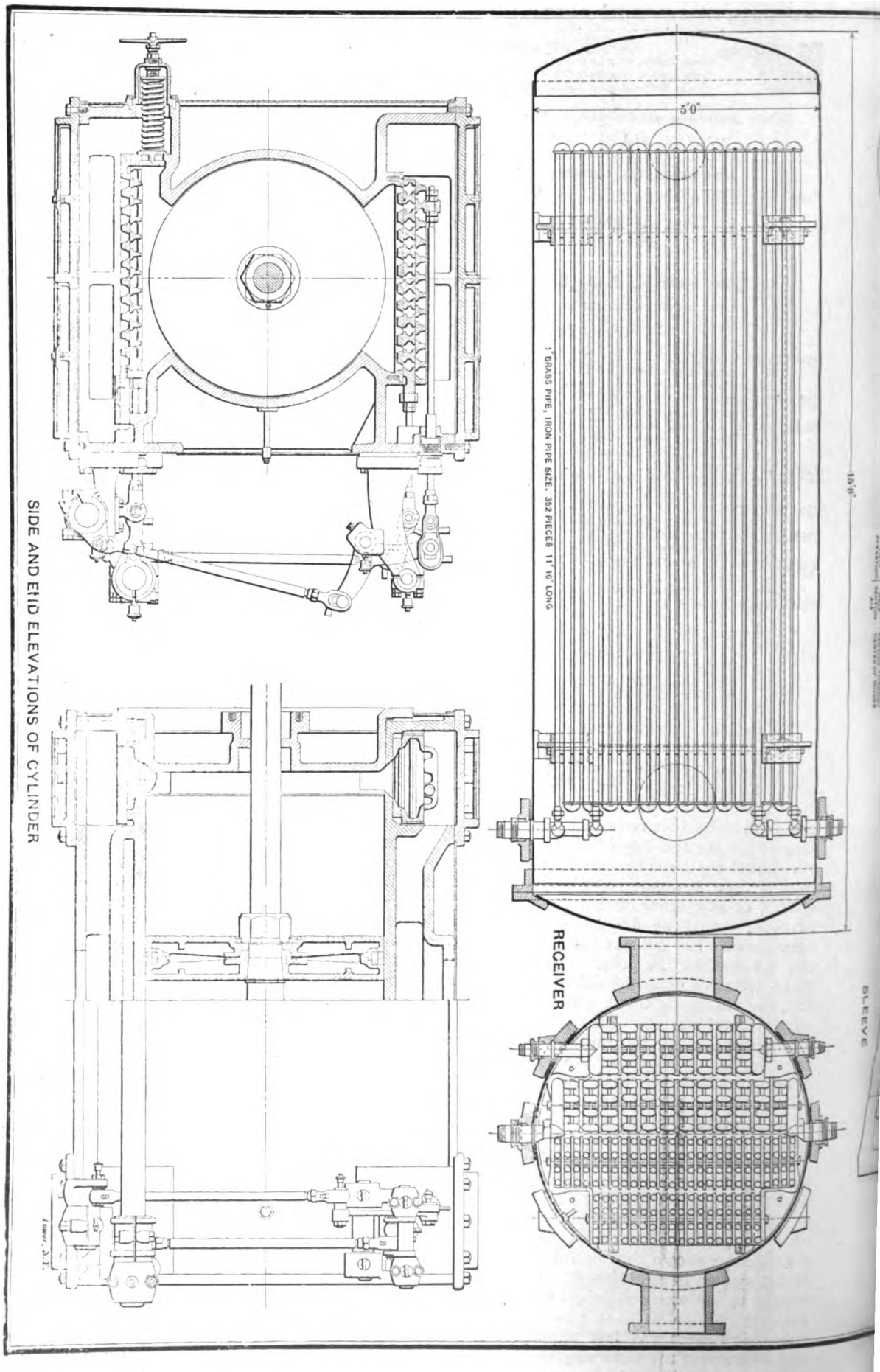

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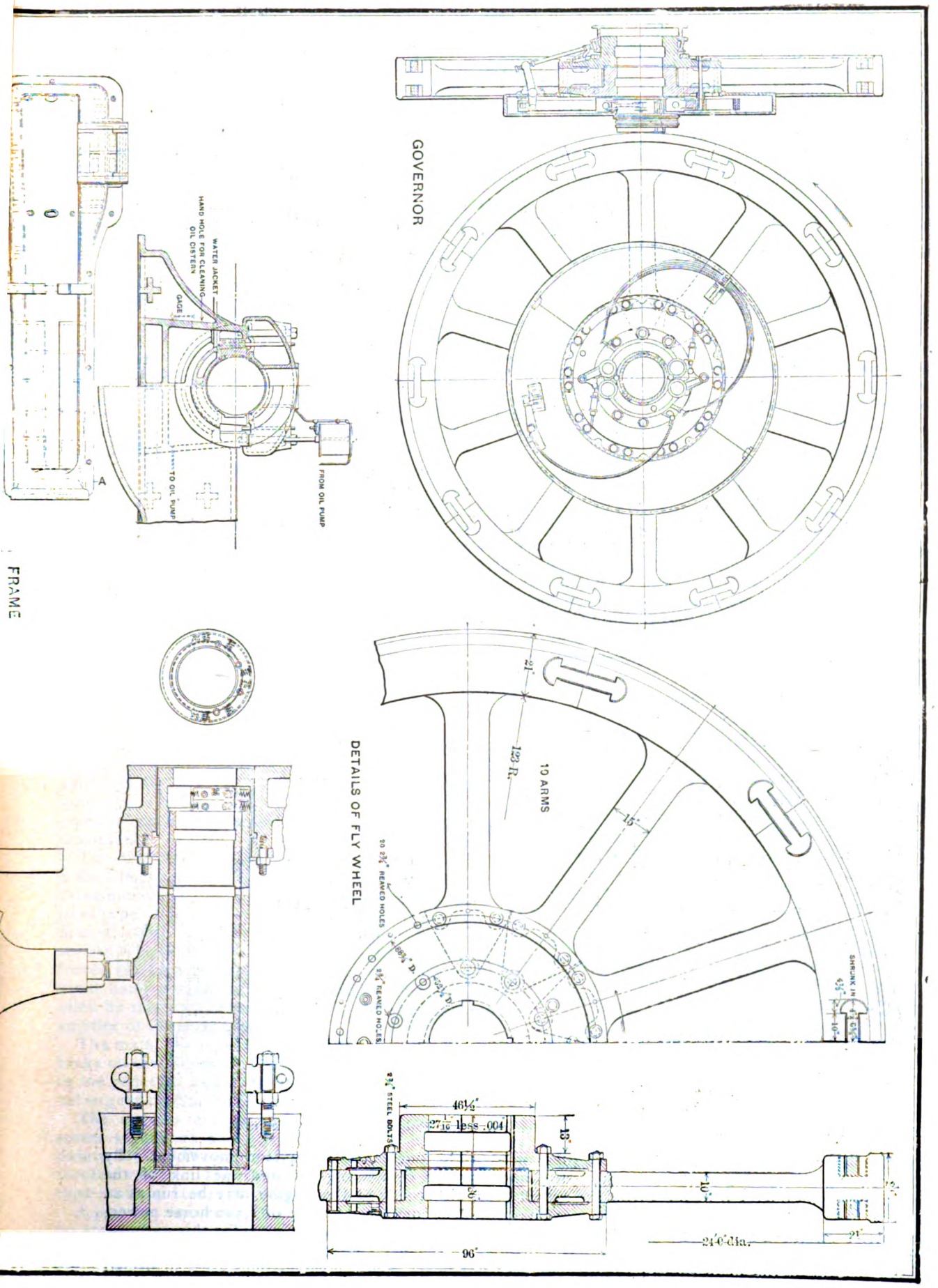

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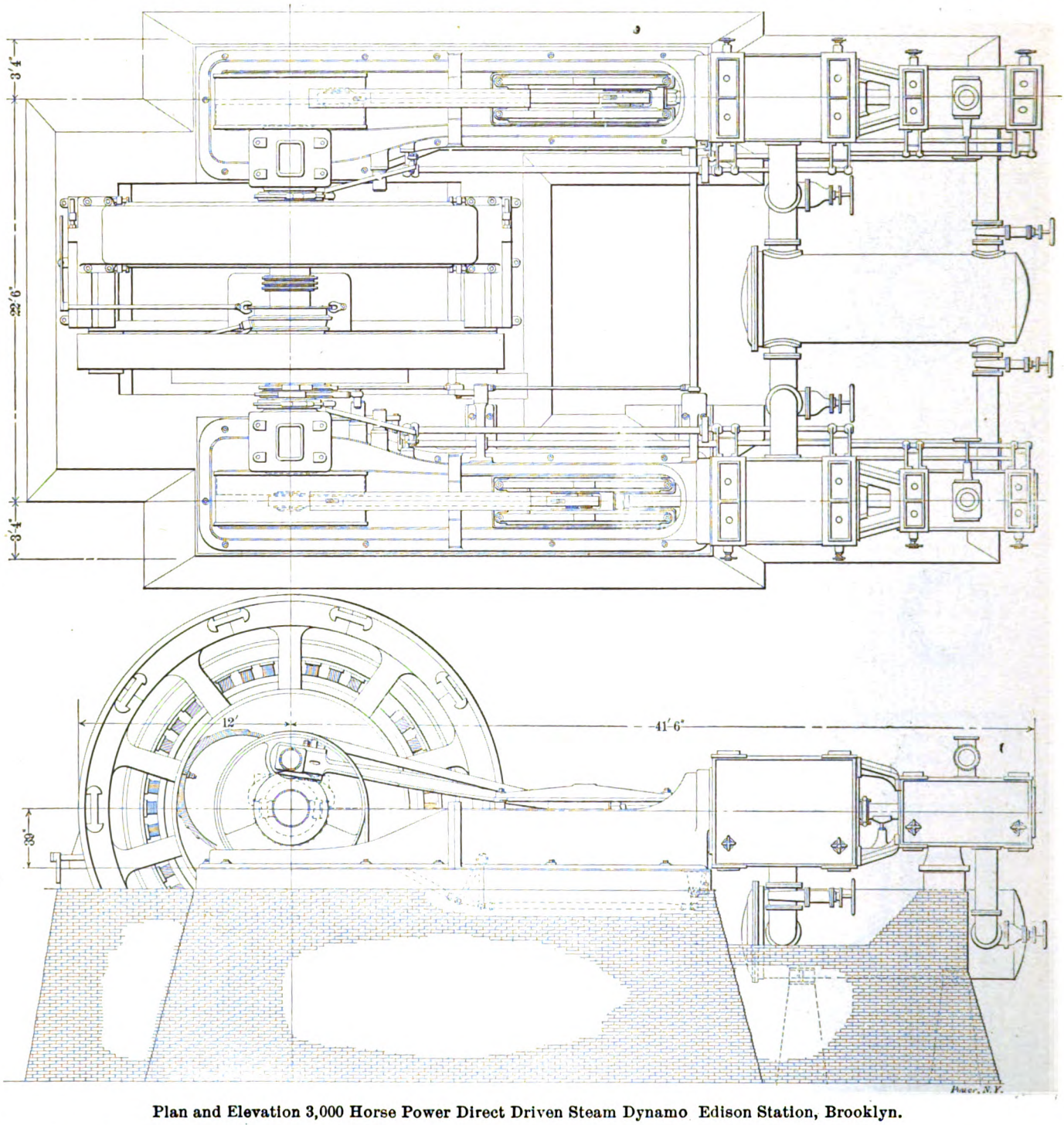
rated horse power. The rim is 24 inches face and 22 inches deep, and weighs about 58 tons, or 37 pounds per rated horse power. It has 10 oval spokes, each cast solid with a section of the rim. The rim sections are fastened together by steel arrow-points, weighing about 300 pounds each, shrunk in. The hub is a casting forced on the shaft by hydraulic pressure, and the spokes are joined to it by 3 2¾-inch turned bolts each.

The valves are of the gridiron type, at four points of each cylinder; the upper valves being for steam and the lower for exhaust. The main valves control the admission of the steam and the opening and closing of the exhaust; they are positively driven, being operated by links from a rock-shaft driven by a bell-crank, which is actuated by links from fixed eccentrics on the main shaft just inside the main bearings. The cut-off valves are also of the gridiron type, and ride on top of the main valves; their movement is imparted by a second rock-shaft on each engine. These auxiliary or cut-off rock-shafts derive their motion from bell-cranks driven by links from the governor eccentrics. There are two of these governor eccentrics, one for each of the twin engines.

The fly wheel, governor wheel and eccentrics being nearer the left-hand engine, a cross-over shaft under the floor is used to communicate the motion to the cut-off gear on the right-hand side of the engine. The governor eccentrics are revolved upon the main shaft by the action of the governor and their angular advance is dependent upon the load and the corresponding position of the governor. The movement of the valves is across the cylinder or at right angles to the piston movement. By disconnecting the connecting rod and one link of the cut-off gear, either side of the engine may be run as an ordinary tandem compound engine of 1,500 horse power; valves being placed in the receiver pipes for this purpose.

The links of the valve-gear are all provided with adjustable brass boxes, and the valve-stems are also adjustable. The clearance required by this type of valve is very small, being but 1 7-10 per cent. in the high-pressure cylinder and 2 2-10 per cent. in the low-pressure cylinder.



Plan and Elevation 3,000 Horse Power Direct Driven Steam Dynamo Edison Station, Brooklyn.

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The connecting rods are 7½ × 9½ inches in section at the centre, and are provided with gib and key adjustment at the ends; pinching-bolts are used to prevent the spreading of the strap. The boxes at both ends are lined with Babbitt metal, hammered in and bored. The piston rods are 7½ inches in diameter, made tapering in the pistons. The pistons bear against shoulders on the rods and are secured by a nut and locking device shown in the outline drawing.

The rod runs in a babbitted sleeve between the cylinders, and an adjustable jack, resting on the split connecting head between the cylinders, supports the weight and provides means for keeping the pistons central in the cylinders. The sleeve is made to be turned 120 degrees at a time, giving three wearing surfaces.

The governor is placed in a flanged disk bolted to the fly wheel; it is clearly shown in the engraving.

At the time this engine was purchased it was considered necessary to provide some means of bringing the several alternators to synchronism before they could be satisfactorily operated in parallel. To this end the builders of the engine devised the governor attachment shown in the outline drawing. The 3-flanged friction pulley shown in the cross-sectional view is loose on the shaft and may be shifted laterally by an ordinary clutch-operator or shifter. This lateral movement brings one or the other of its two right-hand flanges into contact with the small leather-faced disk on the upper end of the diagonal rod. The rotary movement thus imparted to the rod screws it in or out of the nut at the bottom; this in turn varies the tension on the single-leaf auxiliary spring in the governor by means of the connecting levers.

This auxiliary spring acts in conjunction with the main governor spring, and any change in its tension affects the action of the governor, so that the engine speed may be varied while running to suit the requirements of the other machines. The governor and valve gear allow a range of cut-off from 0 to 8-10 of the stroke. The exhaust steam from the high pressure cylinders enters a common reheating receiver, shown on page 2.

This receiver has a brass reheating coil containing steam at boiler pressure. The high-pressure cylinders have steam jackets on both barrel and heads, and these jackets and the receiver are piped in series, so that a constant circulation is ensured by the partial condensation of the steam in the receiver coils. The low-pressure cylinders are provided with warming pipes, and both cylinders have water-relief valves at each end. The steam pipes are each 9 inches and the exhaust pipes 20 inches in diameter.

The lubricating system is of considerable interest. On a shelf between the high and low-pressure cylinders are three automatic force-feed lubricators of the ratchet and pawl type, driven by links from the valve rock-shaft. The first of these lubricates the high-pressure cylinder, the second lubricates the low-pressure cylinder, and the third forces oil into the sleeve between the cylinders. The usual hand pumps are also provided. The crank pin is oiled by the usual centrifugal oiler, and the wrist pin has an oiler of the boat type.

The main bearings are automatically lubricated from tanks on the pillow blocks. Oil reservoirs are provided in the pedestal, and small plunger pumps operated by the valve gear return the oil to the tanks.

The engines are equipped with Cochrane combined steam separators and receivers, built by the Harrison Safety Boiler Works, and are placed directly on the throttle valves. The two condensers are of the surface type made by Henry R. Worthington.

A peculiar feature of this installation is the fact that no steam-driven auxiliaries are used, and the arrangement of the air and circulating pumps is as shown in the engraving on this page. The condensers are placed directly below the engine receiver and are supported by standards from cast-iron base plates, on which the air and circulating pumps are mounted. The air pumps are of the triplex steeple type, connected by means of gears to multipolar slow-speed motors of General Electric make. These pumps have each 6-inch suction and 6-inch discharge. The circulating pump is of the centrifugal type, and is direct-coupled to a multipolar motor running at about 600 revolutions per minute.

The entire arrangement of condensers and pumps is very neat and compact and should be economical in operation. Directly in the rear of the main engine are two 6-pole, 50-kilowatt, 400-revolution, direct-current exciters, each direct-coupled to a 9 and 15 × 16-inch vertical marine type engine of General Electric make.

The makers of the engine make the following guarantees in addition to the usual ones concerning material, workmanship and smooth running:

(1) That the engine will regulate from no load to one and one-quarter the rated load within 1½ per cent. variation of speed.

(2) That the fluctuations in speed under sudden changes in load, amounting to not more than one-half the rated load (the total load not exceeding one and one-quarter the rated load) will not exceed ¾ of one per cent.

(3) That the steam consumption under the most economical conditions will not exceed 13½ pounds of dry steam per indicated horse power per hour.

STRAY CURRENTS.

TELEPHONES IN GERMANY. The most recent telephone statistics for the German Empire bring the numbers up, for Prussia to October, 1897; for Württemberg to April, 1897; for Bavaria only to January, 1897. The general aspect is certainly satisfactory, as a few numbers referring to 1897 and 1894 (in parentheses) will sufficiently indicate. There were 632 (461) towns or places, with 164,681 (110,894) telephone stations and 240,127 (154,435) kilometres of lines, on which 1,440,657 (1,078,865) conversations took place daily. The long distance lines had a length of 90,512 (48,627) kilometres, and 191,884. —Ex.

AN ELECTRIC TRAMWAY IN ITALY. It is proposed to build an electric tramway between Rome and Genzano, with a branch in the direction of Bocca di Papa. The line will be of normal gauge, and the rails will be laid on oak sleepers placed at distances of about 3 ft. apart. The steepest gradient will not exceed 9 per cent., and the sharpest curve 92 ft. radius. The length of the line will be about 26 miles, divided into three nearly equal sections forming a Y. According to "L'Industrie Electrique," the generating station is to be at Capanne de Marino (at the centre of the Y), and will comprise five Dowson gas engines, each of 120 horse power, driving continuous-current dynamos. One of these three sets constitutes a reserve. The station will also supply light to the streets and villas of Castelli Romani. The adoption of gas engines is primarily due to the lack of water. Overhead distribution at 1,200 volts is used, with the rails as return. Motor cars are to be used, with one or two trailers as required. The speed will vary from 9½ to 18½ miles an hour, and each motor will carry two 35-horse power motors.—Ex.

SELF-HARDENING STEEL MAGNETS. In a recent issue of the American Journal of Science are given the results of tests of a large number of magnets made of self-hardening steel, now in common use for lathe tools. The object of these tests was to search for a material for standard measuring magnets which would be as permanent as possible, and have a small temperature and induction coefficient. The experiments show that comparatively short

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seasoned magnets made of this steel have decidedly smaller induction coefficients than magnets of the same dimensions made of tool steel; the difference in the temperature coefficient is much less, but the advantage is still on the side of those made of self-hardening steel; the temperature and induction coefficients of long magnets of the two kinds of steel do not seem to be very different.—Ex.

AMERICAN MACHINERY IN THE FAR EAST. The Westinghouse Electric & Manufacturing Company has taken a contract for machinery to go to China. Consul Ragsdale of Tientsin, under date of July 9, 1898, speaking of the arrival of the new United States Minister, Mr. Conger, mentions the general popularity of Americans in China. Expressions of friendship for our people, he says, are heard in official and business circles. He notes a contract just made by a representative of the Government with Mr. Difenderfer of Philadelphia, for the purchase of all machinery necessary to establish an up-to-date woolen mill at Tientsin. The electrical machinery will come from the Westinghouse Electric Company of Pittsburgh, the boilers and engines from the Harrisburg Foundry & Machine Company, and the remaining machinery from the James Smith Woolen Machine Company of Philadelphia. —Ex.

AILWAY ELPH ES. A telephone experiment is to be tried upon the Baltimore & Ohio that will involve using the telephone for long-distance communication. Work will begin in a few days on the construction of the new copper telegraph lines between Baltimore and Pittsburg, 340 miles, and they will be so arranged that when the necessity arises they will be available for telephonic communication. One of the wires will be extended as far as Newark for telegraphic use. A new line has also been constructed between Columbus and Cincinnati. It will take 800 miles of copper wire, weighing 166 lbs. to the mile, to complete the work.—Ex.

THE BOSTON SUBWAY. Boston's subway, which was built for a little less than its estimated cost of $5,000,000, has been finished and thrown open to the use of the public. The work was begun a little less than 3½ years ago, and in its completed state comprises 1 2-3 miles of tunnel, with 5 miles of railroad track, and in furnishing the means for underground electric transit relieves a congestion in street traffic that was a great nuisance. The subway is the first underground electric road in this country, and its operation will be watched with keen interest. The commission that had charge of the improvement has made plans for a tunnel to East Boston, and has plans for several routes from which a selection is to be made.—Ex.

TELEGRAPHING WITHOUT WIRES

THE DEVELOPMENT OF WIRELESS TELEGRAPHY.

By Sir William Crookes.

The fundamental discovery by Hertz of the electromagnetic waves predicted more than thirty years ago by Clerk Maxwell, says the "Electrical World," seems likely to develop in the direction of a practical application which excites keen interest—I mean the application to electric signaling across moderate distances without connecting wires. The feasibility of this method of signaling has been demonstrated by several experimenters at more than one meeting of the British Association, though most elaborately and with many optical refinements by Oliver Lodge, at the Oxford meeting in 1894. But not until Signor Marconi induced the British post-office and foreign governments to try large-scale experiments did wireless signaling become generally and popularly known or practically developed as a special kind of telegraphy.

Its feasibility depends on the discovery of a singularly sensitive detector for Hertz waves—a detector whose sensitiveness in some cases seems almost to compare with that of the eye itself. The fact noticed by Oliver Lodge in 1889, that an infinitesimal metallic gap subjected to an electric jerk became conducting, so as to complete an electric circuit, was rediscovered soon afterward in a more definite and tangible form and applied to the detection of Hertz waves by M. E. Branly. Oliver Lodge then continued the work, and produced the vacuum filing-tube coherers with automatic tapper-back, which are of acknowledged practical service.

It is this varying continuity of contact under the influence of extremely feeble electric stimulus alternating with mechanical tremor, which, in combination with the mode of producing the waves revealed by Hertz, constitutes the essential and fundamental feature of "wireless telegraphy."

There is a curious and widely spread misapprehension about coherers, to the effect that to make a coherer work the wave must fall upon it. Oliver Lodge has disproved this fallacy. Let the wave fall on a suitable receiver, such as a metallic wire, or, better still, on an arrangement of metal wings resembling a Hertz sender, and the waves set up oscillating currents which may be led by wires (enclosed in metal pipes) to the coherer. The coherer acts apparently by a species of end-impact of the oscillatory current and does not need to be attacked in the flank by the waves themselves.

This interesting method of signaling—already developing in Marconi's hands into a successful practical system, which inevitably will be largely used in lighthouse and marine work—presents more analogy to optical signals by flash-light than to what is usually understood as electric telegraphy; notwithstanding the fact that an ordinary Morse instrument at one end responds to the movements of a key at the other, or, as arranged by Alexander Muirhead, a siphon recorder responds to an automatic transmitter at about the rate of slow cable telegraphy. But, although no apparent optical apparatus is employed, it remains true that the impulse travels from sender to receiver by essentially the same process as that which enables a flash of magnesium powder to excite a distant eye.

TRANSMISSION OF POWER.

THE APPLICATION OF ELECTRICAL MOTORS TO MACHINE TOOLS.

Since 1892 the Mulhausen-Grafenstadten-Belfort Engineering Company has given special attention to the problem of using electric motors for the driving of machine tools, and a series of tests was made to find the best arrangement for varying the speed while obtaining the maximum possible efficiency. After general remarks concerning the various speeds and gears required for different types of machine tools, the author proceeds to describe actual tests of three methods of transmission: (1) Disk and plate; (2) Sellers friction; (3) belt of trapezoidal section. In the first section the following were tested: (a) Sole leather on cast iron; (b) compressed paper on cast iron; lignum vitæ on cast iron; hardened steel on cast iron, and the Sellers disk with cast iron on gun metal.

The electric apparatus consisted of a shunt-wound motor for 110 volts and 3 horse power at 1,200 revolutions per minute, a voltmeter for 120 volts, an amperemeter to read up to 7 amperes, and one to read up to 25 amperes, with switches and adjustable resistance. The mechanical apparatus consisted of a bedplate carrying two Sellers bearings carrying a shaft, upon which was fixed a pulley with a Prony brake, a speed counter-pulley

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and a lever arrangement to measure the end pressure exerted upon the driving gear. The pulley of the Prony brake ran in a bath of soap and water. The whole apparatus was designed to enable the coefficients of friction of the various transmission mechanisms to be readily obtained. The whole of the calculations are given at great length, and finally the results are collected in tabular form, and the values are given for horse powers varying from 0.5 to 2 5. From these the following results for 2 horse power may be selected as fairly typical:

E.H.P.	S.H.P.	Coefficient of Friction.	Efficiency.	
2.861	2.130	0.339	0.7193	Disk and roller, leather on cast iron.
2.764	2.113	0.420	0.7644	Disk and roller, compressed paper on cast iron.
2.764	2.115	0.352	0.7688	Disk and roller, lignum vitæ on cast iron.

From the series of results given in the original the author concluded that the disk and roller are suitable, under certain conditions, for altering speeds for motors up to 2 horse power.

With respect to Sellers disks, the author concludes that the efficiency is lower than that of the disk and roller, but that the apparatus may be used for small powers at speeds not exceeding 1,000 revolutions per minute. The experiments on the transmitting powers of leather belts of a trapezoidal or wedge section are compared with similar results obtained for ordinary flat leather belts. The belt groove has sides inclined to one another at 40 deg. The belt speeds were 1,236, 2,472 and 4,944 feet per minute. With the apparatus in question, it was not possible to obtain the coefficient of friction for the belts, but it was clearly proven that their efficiency was far greater than those of the other methods already described. The author describes various forms of machine tools, and points out how much less room speed cones for wedge-shaped belts take up than cones for ordinary belts.—British Inst. C. E.: Foreign Abstracts.

THE ELECTRIC FURNACE.

THE ELECTRICAL FURNACE AS USED BY MOISSAN.

In a foreign technical journal, Mr. Rudolf Mewes gives an account of the employment of the electric furnace and of the efforts made, before its introduction, to attain very high temperatures. It is pointed out that Moissan claimed for his furnace that it was an appliance strictly for scientific research and not for technical uses. According to the nature of the work to be undertaken, there were five varieties of furnaces, and the strength of the currents employed varied between somewhat wide limits. Diagrams are given of the furnace, and an outline follows of the various researches undertaken by Moissan on the volatilization of certain refractory substances. These served as the basis of experiments upon the crystallization of the oxides of calcium, strontium, marium, magnesium and aluminum, and the oxides of the iron series. Subsequently he investigated the reactions in the electric arc of the metalloids—silicium, boron and carbon, and the distillation of silicic acid.

His later experiments upon the production of carbides and double carbides have led to discoveries which, in the case of calcium carbide, are capable of practical industrial application. He has recently succeeded in producing artificial diamonds by causing molten iron to take up large quantities of carbon; the crucible containing the glowing mass is then rapidly withdrawn from the furnace and plunged into cold water. The result of this is that an outer solid coating is formed which occupies a less volume than the heated mass within, and exerts great pressure on the interior during the cooling process, in the course of which the diamonds crystallize out.

AMONG THE SOCIETIES.

The Engineers' Club of Philadelphia held a meeting Saturday, November 5, at eight P. M., at its house, No. 1122 Girard street. Two papers were read: "Notes on Recent Progress in Electrical Engineering," by Carl Herring, and "Coal Handling Machinery," by Charles Piez. Secretary, L. F. Rondinella.

The Faraday Scientific Society opened its first lecture course, Saturday evening, October 29. The following lectures have been given: "Electro-dynamics," by Maxwell J. Adler, "The Gyroscope," by Otto Greenberg; Maxwell's "Action at a Distance," by Harris Goldstein.

The following lectures are to be given:

Nov. 19—"Photography," by Henry I. Lurye.
Nov. 26—"Steam," by Joseph Miller.
Dec. 3—"Liquefaction of Gases," by David Landau.
Dec. 10—"Psychology," by Abraham Levy."
Dec. 17—"Physical Science in Warfare," by Maxwell J. Adler.
Dec. 24—"On the Fundamental Concepts of Electro-Magnetics," by Harris Goldstein.
Dec. 31—"Volcanoes and Geysers," by Joseph Miller.
Jan. 7—"Electrical Resonance," by Otto Greenberg.
Jan. 14—"Acetylene Gas," by David Landau.

The lectures are given at the Educational Alliance Building, East Broadway and Jefferson street, New York City, every Saturday evening, at eight P. M.

NEW YORK ELECTRICAL SOCIETY.

Mr. E. H. Johnson, president of the Sprague Electric Company, will lecture before the New York Electrical Society on Thursday evening, November 17, at eight P. M., on "Surface Contact Railways, with special reference to the Johnson-Lundell System."

Business News.

SPECIAL EXPORT COLUMN.

TOTAL ELECTRICAL EXPORTS, WEEK ENDING NOV. 7, 1898, $53,044.00.

New York, N. Y. Nov. 7, 1898. The following exports of electrical material are from the port of New York for the week ending this date:

Antwerp—4 cases electrical material, $2,821; 10 packages electrical machinery, $600.

Africa—3 cases electrical material, $457.

Argentine Republic—114 cases electrical material, $5,597; 30 cases electrical machinery, $2,781; 1 case electros, $2.

Brazil—2 cases electrical material, $110.

British Possessions in Africa—4 cases electrical material, $146.

Bremen—6 cases electrical material, $500.

British Guiana—8 packages electrical material, $359.

British West Indies—186 electrical material, $16,867.

Cork—4 cases electrical machinery, $166.

Cuba—44 cases electrical material, $1,159.

Central America—16 cases electrical material, $285.

Chili—15 cases electrical material, $189.

Dutch West Indies—3 cases electrical material, $37.

Dresden—2 packages electrical material, $27.

Ecuador—6 cases electrical material, $125.

Glasgow—8 packages electrical material, $856; 4 cases electrical machinery, $123.

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Hong Kong—11 cases electrical material, $714.
Japan—2 electric motors, $790.
London—184 cases electrical material, $7,200; 21 cases electrical machinery, $1,560; 1 case electros, $117.
Liverpool—12 packages electrical machinery, $220; 12 cases electrical material, $291.
Mexico—17 cases electrical material, $792; 5 cases electrical material, $50.
Newfoundland—6 packages electrical material, $58.
Nova Scotia—1 package electrical material, $24.
Newcastle—16 packages electrical material, $25.
Odessa—29 cases electrical material, $916.
Peru—21 cases electrical material, $387; 3 cases electrical machinery, $490.
Porto Rico—60 packages electrical material, $1,304.
Rotterdam—1 case electrical machinery, $300.
Siam—27 packages electrical material, $700.
Santo Domingo—8 cases electrical material, $75.
Southampton—8 cases electrical material, $628.
Uruguay—1 case electrical machinery, $739; 8 cases electrical material, $203.
U. S. Colombia—44 packages electrical material, $1,154; 3 cases electrical machinery, $704.
Venezuela—2 packages electrical material, $27; 7 cases electrical material, $80.

POSSIBLE INSTALLATIONS.

Hagerstown, Md.—The Mayor may be addressed concerning establishment of electric light plant.

Spartansburg, S. C.—The Ætna Light & Power Co. will have plans and specifications prepared for a new gas and electric light plant.

Franklin, Tenn.—D. F. Gardner is reported to be interested in the establishment of an electric light plant.

Woodsfield, W. Va.—The Town Clerk may be addressed concerning electric light plant, for which bonds will be issued.

Yazoo City, Miss.—L. G. Montgomery is reported to be interested in the establishment of an electric light plant.

Charlevoix, Mich.—City Clerk may be addressed concerning proposed establishment of electric lighting plant.

Henderson, Tenn.—City Clerk may be addressed concerning proposed electric light and street railway service.

STREET RAILWAY NEWS.

Fort Smith, Ark.—The Fort Smith Traction, Light & Power Co. has been incorporated by Alfred N. Sicard, Ella E. Sicard, Richard C. Kern, Charles H. Smith and others. Capital stock, $200,000, of which $100,000 has been subscribed and paid up.

Newport News, Va.—The Newport News & Old Point Railway & Electric Co. will expend about $200,000 in improving the railway, light and power plants which it has purchased, and in erecting a new electric-power plant.

Middletown, N. Y.—The Middletown Traction Co.; receiver has been appointed.

TELEPHONE CALLS.

Germantown, Ky.—The Germantown, Minerva & Maysville Telephone Co. has been incorporated by J. F. Walton, S. D. Rigdon, T. M. Dora, Evan Lloyd and others.

Greensburg, Ky.—Green County Telephone Co. has been incorporated with a capital stock of $3,500.

NEW INCORPORATIONS.

Portland, Me.—Mitchell-Parson Electric Co. has been incorporated by Geo. A. Copeland and Wm. E. Parson; to manufacture electric car appliances. Capital stock, $150,000.

Camden, N. J.—Citizens' Light, Heat & Power Co. has been incorporated by Andrew S. Scull, Joaphim R. Moon and Wesley Bartine; to manufacture electricity for light, heat and power. Capital stock, $100,000.

NEW YORK ITEMS.

H. STILLSON HART has opened up offices in the White Building, 95–97 Liberty street, for the Fostoria Incandescent Lamp Co. This will also be the eastern office of the Crouse-Tremaine Carbon Co.

THE MONTAUK MULTIPHASE CABLE COMPANY are making an exhibit of their interior thermostatic fire cables at the twentieth Triennial Exhibition of the Massachusetts Charitable Mechanics' Association at Boston. The exhibit is in charge of Mr. Lucian W. Jenney, who also had charge of their exhibit at the Electrical Show in this city last May.

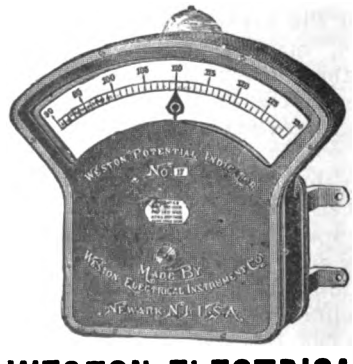
THE AMERICAN ENCLOSED ARC LAMP, manufactured by C. J. Bogue, 215 Centre street, has made a great hit, and orders for the lamp are literally pouring in thick and fast.

MR. ELMER P. MORRIS, the well known electrical supply agent, of 15 Cortlandt street, is well satisfied with present business conditions, the many fine orders which he is receiving contributing largely to his satisfaction.

THE INDIA RUBBER & GUTTA PERCHA INSULATING COMPANY are about completing a $250,000 contract for the Government, and are kept extremely busy filling orders for their well known "HABIRSHAW" brands of insulated wire. Visitors are always welcome at headquarters, 15 Cortlandt street.

The October 13th edition of the BROOKLYN DAILY EAGLE contained an account of the death of Charles Delos Doubleday, of Brooklyn, an electrician. The item caused a great deal of sorrow among the numerous friends of C. D. Doubleday, the well known supply man of Manhattan, they being under the impression that it was he who had passed into the land of shades. We desire to assure the friends of the Manhattan Doubleday that he is still one of us, as hearty and robust as ever, and any one calling at his office at 137 East 33d street, Manhattan, will receive a welcome which will leave no doubt in his mind as to the present status of C. D. Doubleday, of Manhattan.

WESTON STANDARD ILLUMINATED DIAL



STATION INSTRUMENTS.

THESE INSTRUMENTS are based upon the same general principle and are just as accurate as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger, and the working parts are inclosed in a neatly designed dust-proof cast-iron case, which effectively shields the instruments from disturbing influences of external magnetic fields.

WESTON ELECTRICAL INSTRUMENT CO.
114-120 William St., Newark, N. J., U. S. A.

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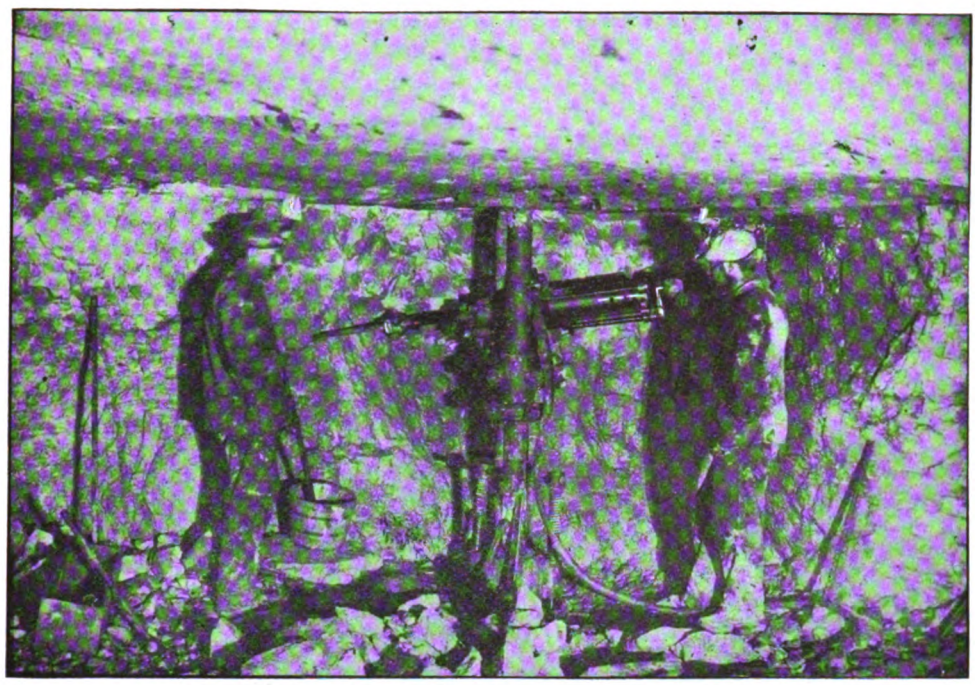
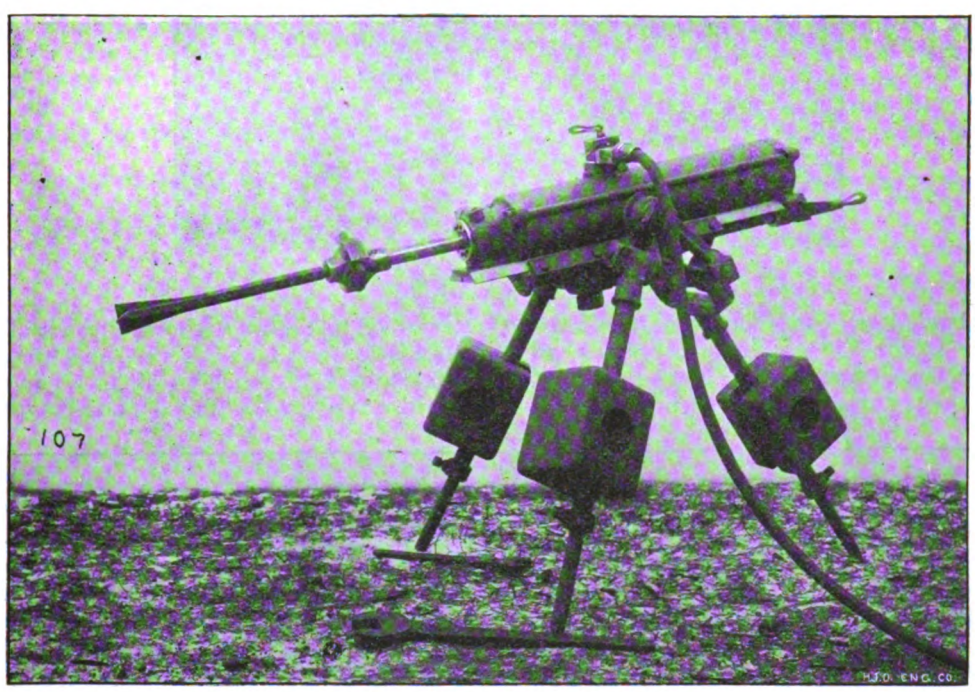
The Electrical Age.

VOL. XXII—NO. 21 NEW YORK, NOVEMBER 19, 1898 WHOLE NO. 601

ELECTRIC MINING.



Marvin Drill Underground.



Marvin Drill Mounted on Tripod.

ELECTRIC ROCK DRILLS.

The inception and growth of the electric drill has been of sufficient importance to excite considerable interest among mining engineers. The electric rock drill, a drill driven by electricity, has become an element in mining operations of considerable value. A highly perfected economical and durable electric drill is manufactured by the Marvin Electric Drill Company, of Canastota, N. Y. A great deal of steady care and experiment has been devoted to the perfection of the Marvin electric rock drill. The problem is not a very simple one, but we can state, with considerable pleasure, that it has been solved to the satisfaction of many mining experts, by the above concern. In tunnel and quarry work a class of mining is met with that puts to the severest tests any rock drill, whether operated by steam, compressed air, or electricity.

The fact that a successful rock drill must be simple, strong and economical, is a common-sense conclusion that would be arrived at from a most casual review of the circumstances, but the demand is most emphatic on the part of mining engineers that an electric drill shall be cheap to operate and inexpensive to maintain.

The "Mining & Metallurgical Journal" speaks most

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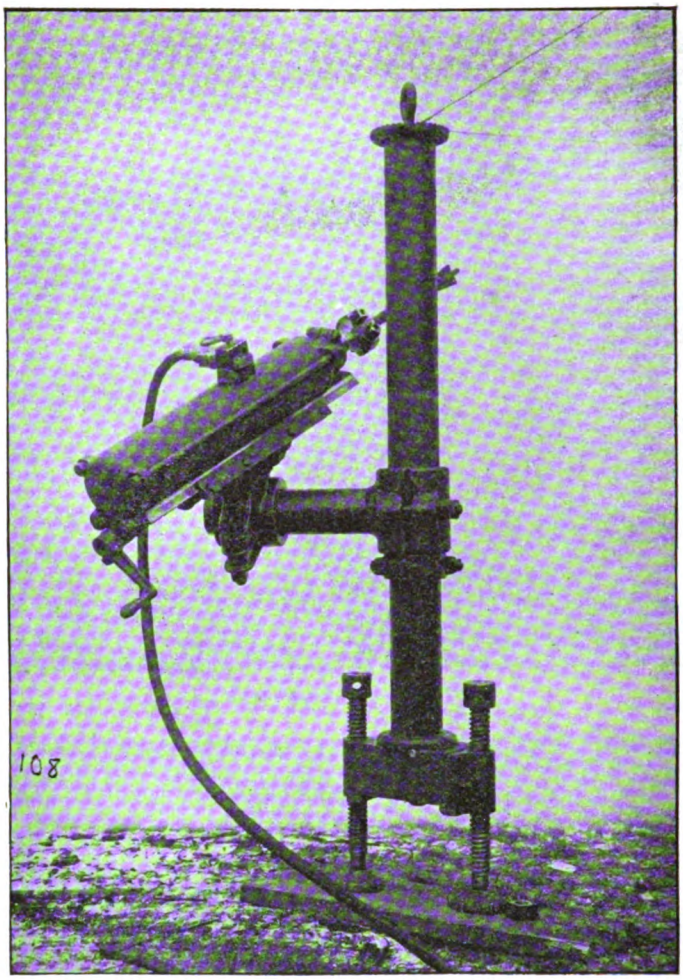
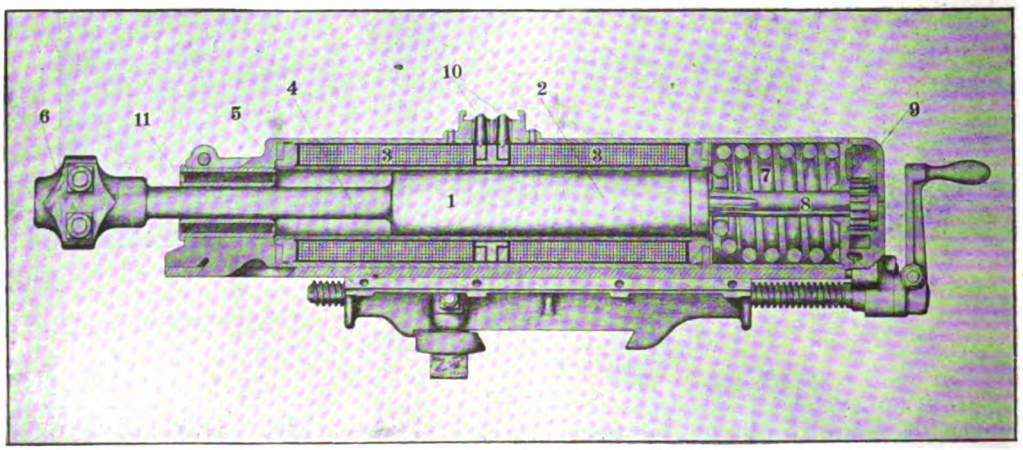
intelligently upon the subject of electric rock drills in mining, as follows: "those who have watched the development of electrical engineering will realize that today electrical apparatus is turned out which embodies the most rugged mechanical design and high electrical efficiency. Electricity lends itself especially to power transmission, owing to the readiness with which the wires can be strung and the small cost necessary. The advantages of an electric system over any other mode of power transmission is a commonly accepted fact. Wires may be strung in a most temporary manner and branch lines may be carried to distant points where the power is required without a large outlay of money and requiring practically no expense to keep in order. In prospecting work where it becomes necessary to convey the power a long distance, and across rough and mountainous country, the electric wires present none of the difficulties encountered in running a pipe line or moving a boiler from point to point as the work changes; and moreover, the wires may be quickly shifted or extended inexpensively as the work changes.



Marvin Drill Mounted on Column.

Referring to Figure 1, showing the section of a Marvin electric drill, it will be observed that the construction of this machine is extremely simple. The main portion of the drill consists of a coiled body comprising two coils of wire, 3 and 3, which form a double solenoid. Within this solenoid is developed the magnetic core, which actuates a soft steel plunger moving it to and fro as steam affects the piston in steam drill. The plunger is a soft steel forging reduced in section throughout one portion and at the end is formed a massive chuck to receive the bit. The plunger is indestructible and will withstand the



Sectional View of Marvin Drill.

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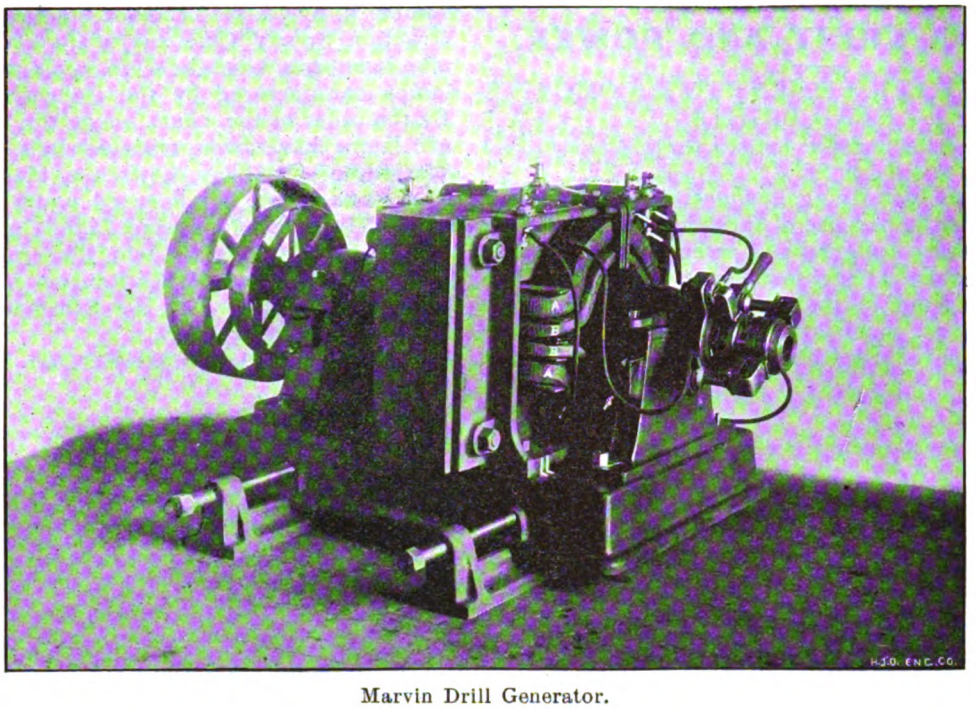
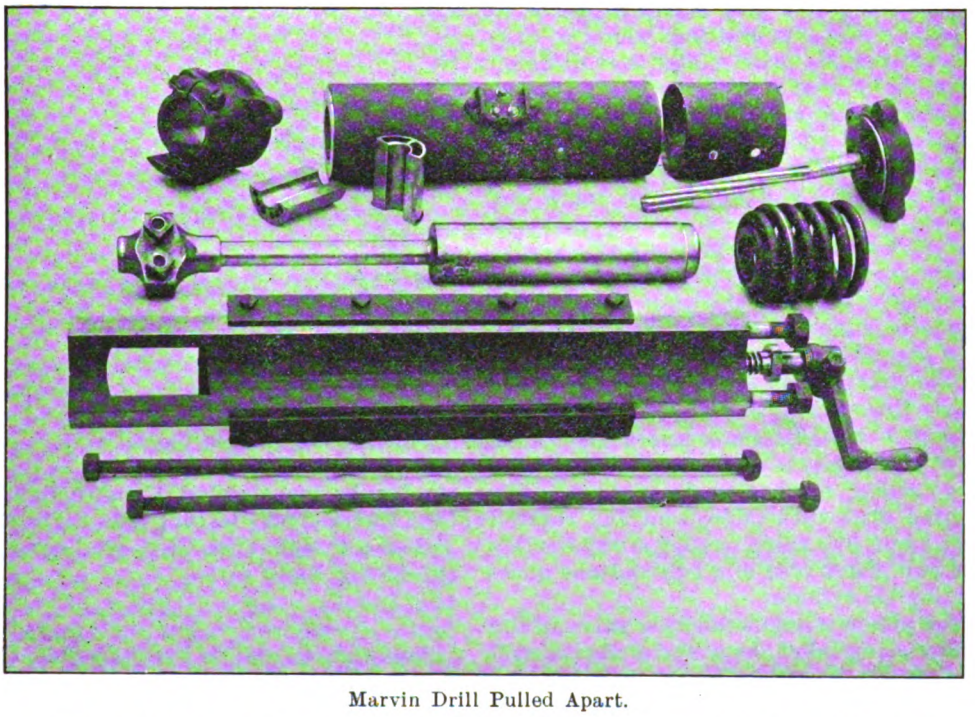
shock of the blow without breakage or crystallization. The coils are wound with square copper wire and insulated between layers and turns with pure India mica, thus rendering the coils mechanically indestructible and fireproof in case they receive more current than represents their normal capacity. These coils are encased in an iron jacket, which is caulked to the heads of the coil, thus making the coil absolutely water-tight. The current is directed into the two coils in alternation by the generator itself, thus doing away with anything in the nature of a valve or switch on the drill. The backward stroke of the plunger is checked by the buffing spring No. 7 which returns the energy momentarily stored in the spring to the forward stroke. The turning of the plunger is affected by a rifled bar and ratchet device in the baek head similar to that used in other drills. All parts of the drill are equally strong, and in the hands of the most ignorant man no damage can be done to the machine. The wearing parts can be easily and cheaply renewed.

"By referring to Figure 2, showing the drill pulled apart, it will be observed that the different parts of the drill interlock and are held together by two side bolts and two studs, the latter being integral with the concaved slide upon which the different parts are held. The generator shown by Figure 2, for operating the drills, is an extremely simple machine, being so designed that it can be taken down and packed into boxes not exceeding three hundred pounds each. This feature becomes necessary in order that the apparatus may be transported on mule back. Three wires are carried from the generator to the centre of the working area, where branch lines may be led to the different drills. The drills operate independently of one another, and the generator regulates the voltage so that each drill will receive the proper amount of current."



Marvin Drill Generator.



Marvin Drill Pulled Apart.

In Figure 4 the six-inch drill is shown mounted on an adjustable column for tunnel or general underground work. In Figure 5 the six-inch drill is represented in

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actual operation underground. In Figure 6 the seven-inch drill is shown on tripod mounting.

This condensed description covers the most prominent features of the Marvin electric rock drill, the success of which has been so pronounced as to leave no doubt whatsoever of their general employment for the purpose outlined in practical mining operations.

ELECTRIC LIGHT AND POWER.

SEARCH-LIGHT ATTACHMENT TO LOCOMOTIVE HEAD LIGHTS.

Through the courtesy of the "American Engineer, Car Builder and Railroad Journal.")

An arrangement for turning locomotive headlights on a vertical axis for the purpose of throwing the light upon the tracks on curves, designed and patented by Mr. John S. Thurman, mechanical engineer of the Missouri Pacific Railway, is illustrated in the accompanying engraving. The drawing shows an electric head light with a motor and dynamo mounted together on a table, on the under side of which the turning mechanism is secured. The headlight is mounted on a turn-table, which is rotated through the proper angle by a cable passing around pulley and leading to the two piston rods of a two-and-one quarter-inch double-acting air cylinder.

The motion of the piston is regulated by a valve in the cab, the air pressure being taken from the air-brake system. The surface on which the headlight turns is in the form of inclines, so arranged that when the headlight travels up the incline it will have bearings on the two quarters on which it travels. The object of this is to return the headlight to its normal position automatically when the air is released. The device has been tried on three western roads and the engine men like it. They say that they can see ahead as well on curves as on straight tracks. It is equally well adapted to headlights using oil.

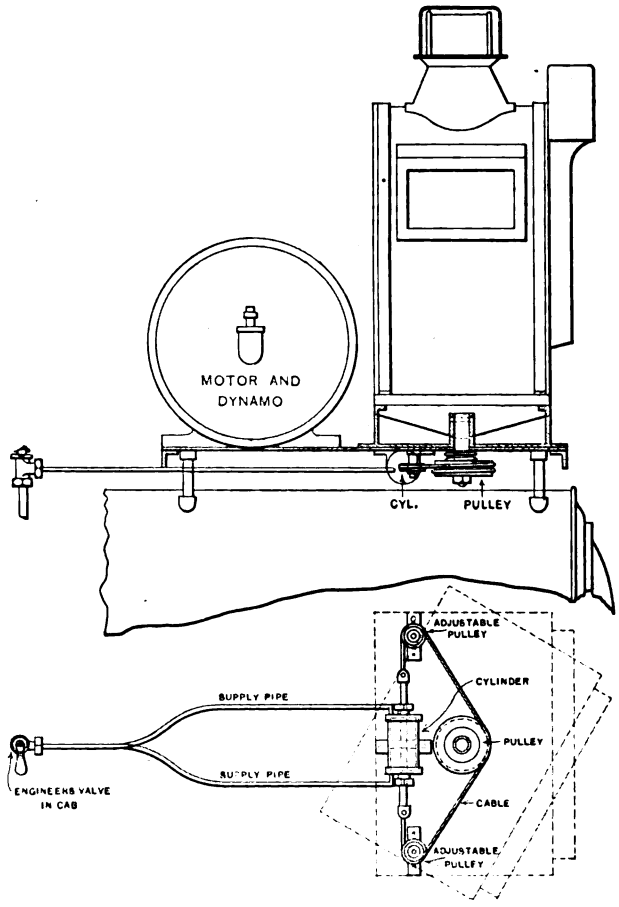

Diagram of Search Light Attachment to Locomotive Head Lights.

ANOTHER INJUNCTION IN FAVOR OF THE MARKS ENCLOSED ARC LAMP.

The injunction issued October 18, 1898, by Judge Coxe, restraining the Washington Mills Company, New York, from infringing the Marks-Ransom enclosed arc method patent, and the permanent injunction issued November 5, by Judge Lacombe, against the Electric Construction Supply Company, manufacturers of the Kinsman lamp, has been held to apply to the enclosed arc lamps manufactured by the General Electric Company. By the order of the court 40 of this company's enclosed arc lamps have been removed from the factory of the Washington Company, Lawrence, Mass., and other lamps of the same type, but licensed under the Marks patents by the Marks Enclosed Arc Light Company, are now being substituted. It is held that the General Electric lamps infringe the Marks-Ransom patent, and are enjoined under clause 4 of the Kinsman injunction decree, issued November 5, 1898.

The Enclosed Arc Light Co., 120 Liberty street, city, the Manhattan General Construction, 11 Broadway, and the General Incandescent Arc Light Co., 1st avenue and 33d street, New York City, are licensed by the Marks Enclosed Arc Light Co.

Franklin, Pa.—The Franklin Steel Casting Company is installing an electric light plant in its power house.

Independence, Mo.—A franchise for the erection of an electric light and ice plant has been applied for by W. T. Felton, of Kansas City, Mo.

Fredericksburg, Va.—Address the Mayor regarding estimates which are to be obtained on the construction of electric lighting plant.

Clarence, Mo.—Five thousand dollars have been voted for an electric light plant.

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THE INCREASING USE OF ALUMINUM.

Tradition sometimes tells us in her old-fashioned, feeble way that aluminum is not so new that this century has seen the first of it. It might have been better for us had it been an older metal, industrially, but in view of the fact that it is a new product produced by a new power, it possesses an interest for us which makes each new application of this strange white metal the subject of continued remark. The future of aluminum is slowly unveiling itself. In the field of applied electricity electricians have discovered a direct gain in its use as an electrical conductor. The possibilities in store for it are correspondingly great in the building trade, but it seems as though its greatest success will be found only when alloyed with other metals. Aluminum alloys have properties which render aluminum in this state, and acting as the preponderating element, a metal that has tremendous advantages over the alloys of brass and such an unsatisfactory metal as cast iron.

One of the most remarkable properties of aluminum is that it renders certain alloys more fluid at lower temperatures than either gun metal, for instance, or other brass mixtures. Mitis metal, which possesses high permeability, is practically a slight alloy of aluminum and cast iron. It is supposed that aluminum acts as a flux for certain foreign elements in the crude cast iron, thereby giving a nature and consistency to the remaining metal which makes it approach in appearance and strength wrought iron. The use of aluminum, therefore, in conjunction with other metals is not new in this profession, although it has never met with any broad applications.

A new product called aluminum brass stands a strain of thirty thousand pounds per square inch as its elastic limit. This may be improved upon sufficiently to reach forty or fifty thousand pounds, the degree of elongation not exceeding three per cent. The advantage of improving upon aluminum alloys sufficiently to make them possess great tensile strength and comparative lightness is self-evident to those entrusted with the erection of an extensive transmission plant. The cost of erecting a long line depends largely upon the weight of the conductor to be supported upon insulators. In this respect aluminum, while not at present superior to copper, still holds its own sufficiently to be utilized for power lines miles in length. The non-corrosibility of aluminum is a large item in its favor. In tropical countries, particularly during the rainy season, the corrosion of copper wires is most marked, and it seems likely that the substitution of aluminum wire in its place might in some few installations be of decided benefit.

The aluminum of today is a characteristic electric product, as are carborundum and carbide of calcium. The industrial value of these three is increasing year by year, and as our horizon increases we see more clearly the great benefits civilization has already derived from these important advances.

PATENT LAW IN AUSTRIA.

On the seventh of January, 1899, the new patent law of Austria prevails. It is based on the German law through which a patent must pass a body of experts or board of examiners empowered to grant or refuse a patent. This puts considerable arbitrary power into the hands of those entrusted with this great responsibility, and it is to be hoped that they will never cease to regard a public office as a public trust. Under the new law of Austria patents are granted for a term of sixteen years on inventions which relate to the industrial arts, and unless in the line of medicaments, foods, chemical products which which have caused to be originated new processes, a patent grant is not possible. One peculiar phase of the Austrian patent law is that which gives the government or war officials freedom to use new devices in the line of armament, war vessels, ammunition, and to pay for such whatever is deemed in their judgment a fitting value. The patent office may also grant licenses even in cases where the patentee objects. In many respects the power of the patent office has been greatly increased, but at the same time no evil consequences will result from this further extension of power if able men are selected whose judgment will be in all cases perfectly unbiassed.

THE RUBBER INDUSTRY.

To quote from our esteemed contemporary, "The Trade Journals' Review," we find that the United States has done exceedingly well in rubber. The increase in output has gone up from twenty-five to fifty per cent. This has been explained by the increased demand for bicycle tires and rubber-covered wire. A new material, called textiloid, a substitute for rubber, has been invented and introduced by Eugene Cadret, of Paris. Its chief ingredient is oil. Textiloid, before being marketed, is exposed to a pressure of from two hundred to three hundred atmospheres. Very little, however, has been said of its electrical properties.

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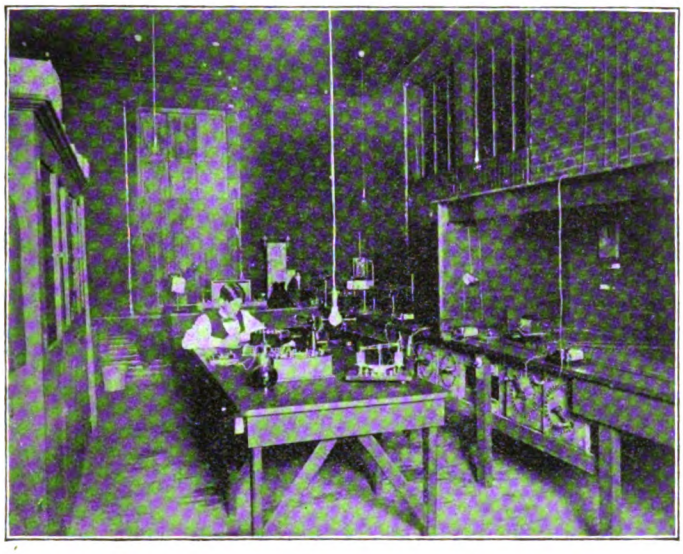
INCANDESCENT LAMP MANUFACTURE.

THE MANUFACTURE OF MODERN INCANDESCENT LAMPS.

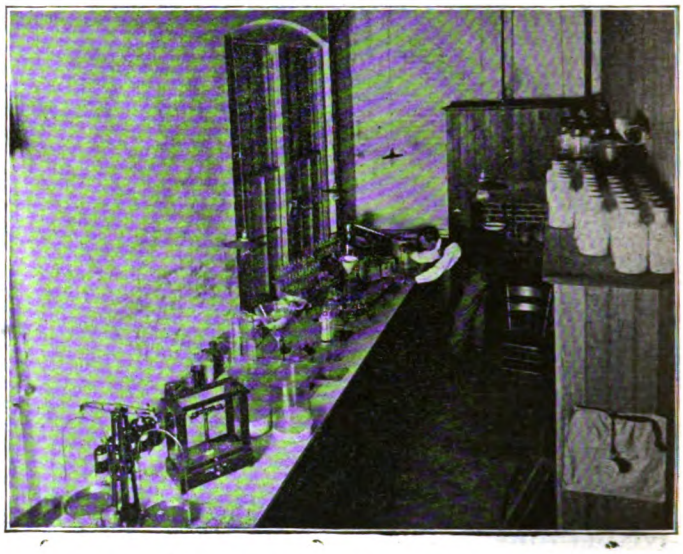
The features that constitute a good incandescent lamp and which must be taken into consideration by the purchaser are long life and high efficiency. In many cases efficiency is secured at the expense of durability, and it is only when both of these qualities exist that a lamp may be said to be a commercial success. To manufacture an incandescent lamp appears on the face of it to be a comparatively simple process, but in detailed development and long list of precautions there are few, if any, manufactured articles that require more delicate attention. In 1896 the Shelby Electric Company was organized by a number of wealthy financiers. The object of this concern was the manufacture of a high-class incandescent lamp built upon such lines as those demonstrated to the incorporators by Prof. A. Chaillet. This company was organize with a capital stock of $100,000, with but one object in view, to produce a lamp of superior qualities, whose hold upon the consumer would be sufficiently strong to make it unique among its competitors.

A series of illustrations have been appended to this article for the purpose of showing the processes through which the Shelby lamp passes. One of its particular features is the shape of the stem supporting the filament. Another is the complete absence, due to special construction, of the so-called "Edison" effect. Another, and not least important, is the remarkable properties of the filament. In this respect the company claim a knowledge of the art of lamp making far in advance of that possessed by others.

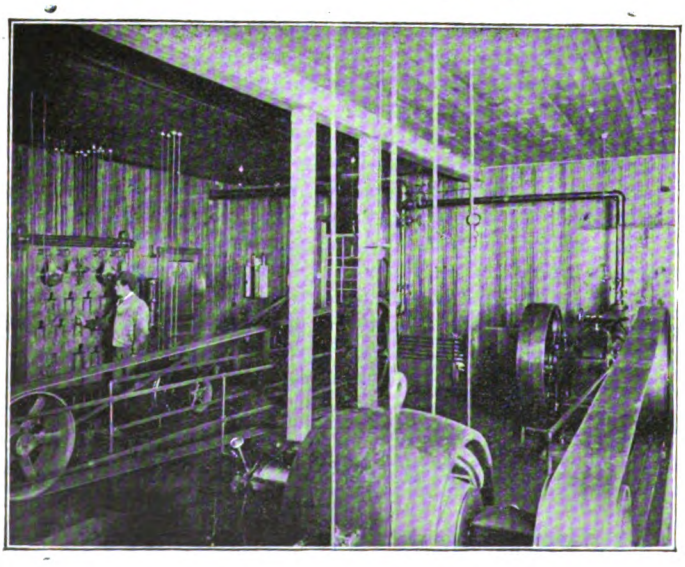
The materials of which the filaments are composed are kept secret, but the shaping, coiling into three loops, etc., may be viewed by any other visitor to their establishment. The stem of the Shelby lamp is of U shape. This absolutely prevents any possibility of short circuit to the terminals. The joint between the stem and base is absolutely moisture-proof; the leading-in wires by the completeness of their insulation destroy all possibility of the "Edison" effect occurring, referred to above. The effective separation of the leading-in wires is more advantageous than is generally supposed. No better proof of the modern construction of this lamp can be brought forward than the fact that it is tipless. The bulb is continuous and perfectly spherical at the end where the tip is generally found in other makes. This is a decided advantage and indicates a close study of the details of construction and design. Appreciation of this is shown by a de-



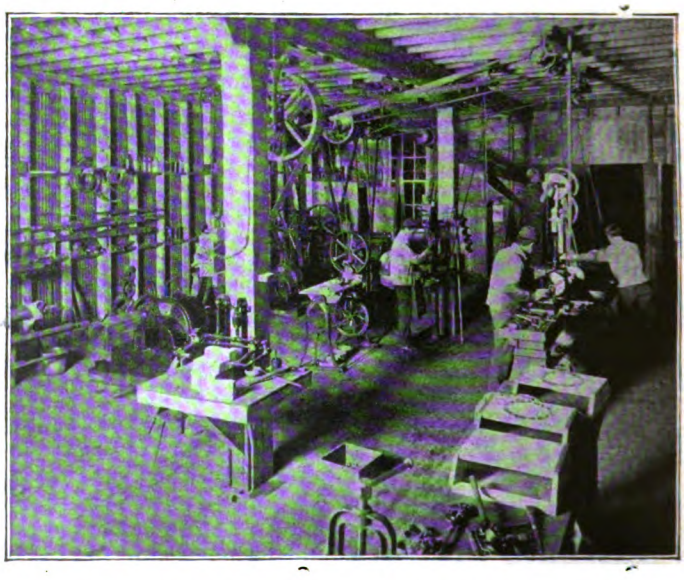
One End of Physical Laboratory, Shelby Electric Co.



One End of Chemical Laboratory, Shelby Electric Co.



Corner in the Engine Room, Shelby Electric Co.



Corner in the Machine Shop, Shelby Electric Co.

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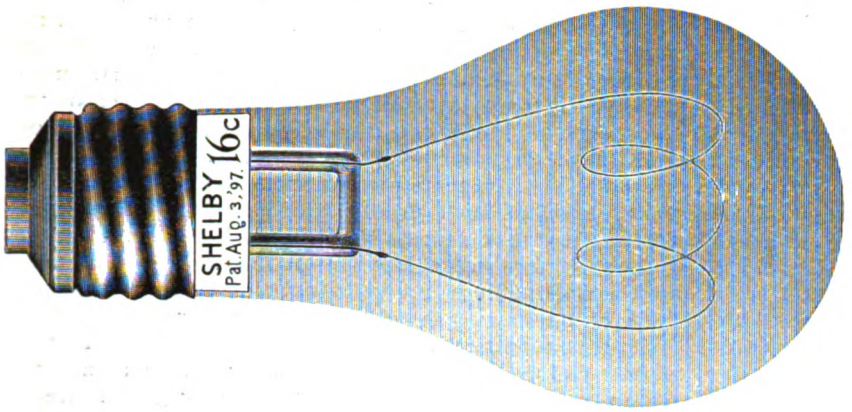
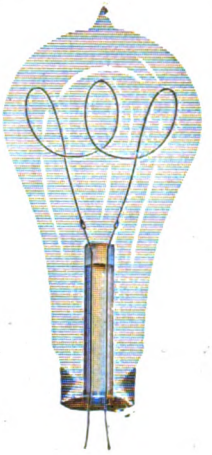
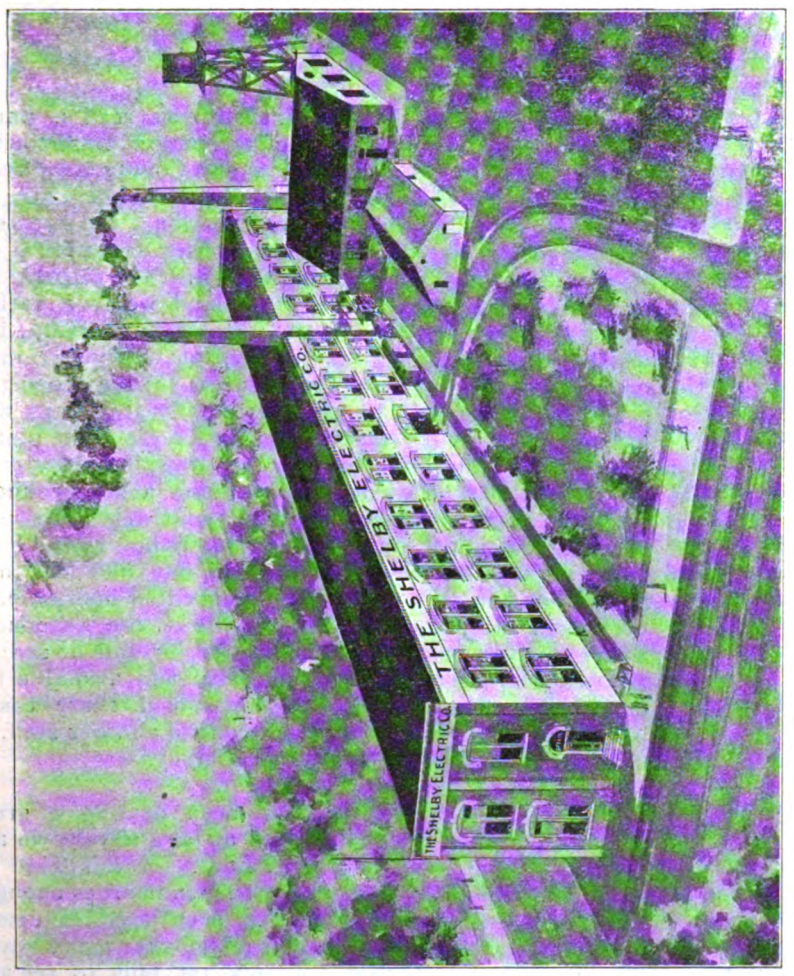
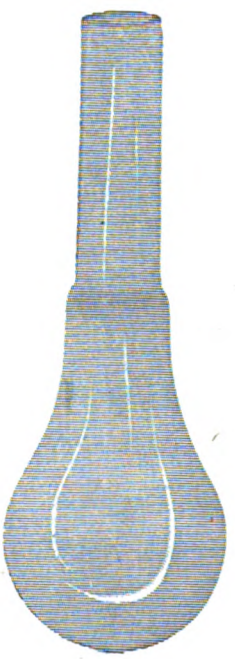
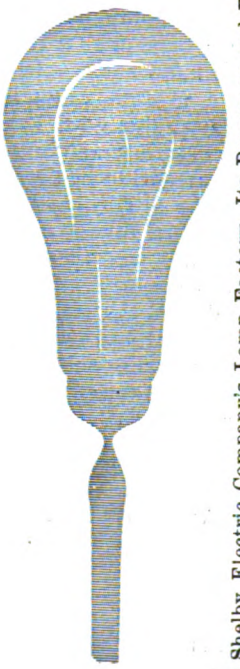


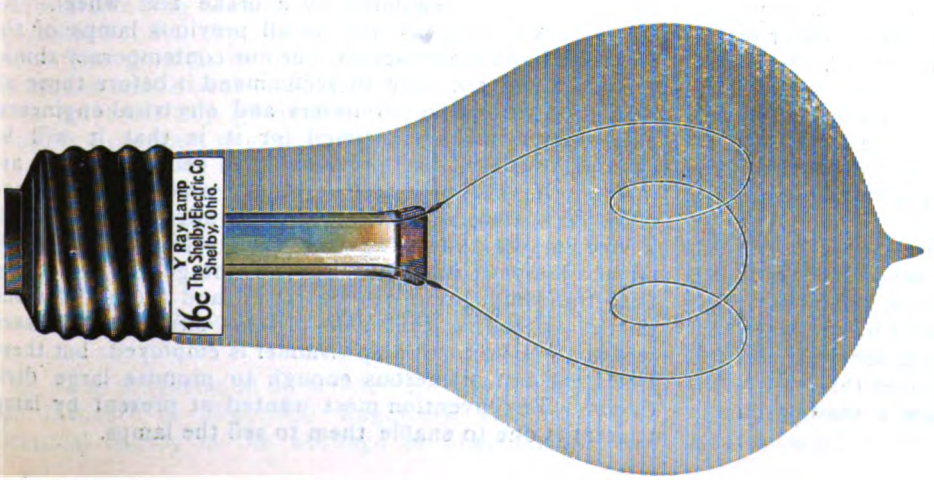


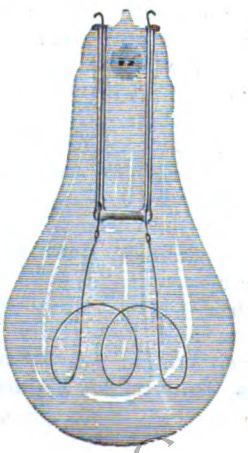






The Shelby Electric Company's Lamp Factory, Its Processes and Products.





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mand exceeding 5,000 lamps a day, which will lead in the near future to a radical increase in the size of the factory.

The sketches of the different conditions of the lamp bulb may be further interpreted by the following: When the bulb is ready for the lamp maker it is washed and dried by means of an air blast. The stem containing filament is fused in. The quadrilateral shape of the support holding the filament and carrying the terminals gives the lamp an up-to-date and business-like appearance. After sealing the stem into the lamp, niches are made in the neck for the purpose of having the plaster adhere not only by surface contact, but by a species of dovetail. The testing of the lamps is interesting in so far as they are taken into a dark room and exposed to the terminals of an induction coil of thousands of volts' pressure for the purpose of determining the degree of vacuum they possess. Unless the vacuum is "dead black," as the technical phrase goes, which condition is determined by the glow, the lamps are exhausted still further.

Nearly every lamp turned out by the Shelby Electric Company can be used as standard. The variation in candle power, pressure and wattage of one or the other is so slight as to make the difference negligible. The candle-power test of each lamp, the vacuum test, and the ultimate packing of the lamps for shipment represent phases in the history of Shelby lamps which are very instructive and deeply interesting.

The company has met with remarkable success, and it may be said that it is as much due to the high perfection the lamp has reached in their hands as to the clockwork-like system prevailing in their factory. It seems as though one goes hand in hand with the other, and that success in manufacturing depends entirely upon the closest attention to these two factors.

The Shelby factory is at Shelby, O. About one hundred and eighty employes occupy the premises, which are two hundred feet long and sixty-four feet wide. Many girls are used in their factory, their lightness of touch and skill in certain departmeuts of the work making them the best help obtainable. The office force of the company is connected by a private telephone system. The scientific department is in the hands of trained chemists, experienced engineers and first-class electricians.

A COMMUNICATION FROM NIKOLA TESLA.

NEW YORK, Nov. 18th, 1898.
46–48 E. Houston street.

EDITOR OF THE ELECTRICAL ENGINEER,
120 Liberty street,
New York City.

SIR:—

By publishing in your columns of November 17th my recent contribution to the Electro-Therapeutic Society you have finally succeeded—after many vain attempts made during a number of years—in causing me a serious injury. It has cost me great pains to write that paper, and I have expected to see it appear among other dignified contributions of its kind, and, I confess, the wound is deep. But you will have no opportunity for inflicting a similar one, as I propose to take better care of my papers in the future. In what manner you have secured this one in advance of other electrical periodicals, who had an equal right to the same, rests with the secretary of the Society to explain.

Your editorial comment would not concern me in the least were it not my duty to take note of it. On more than one occasion you have offended me, but in my qualities both as Christian and philosopher I have always forgiven you and have only pitied you for your errors. This time, though, your offence is graver than the previous ones, for you have dared to cast a shadow on my honor.

No doubt you must have in your possession, from the illustrious men whom you quote, tangible proofs in support of your statement reflecting on my honesty. Being a bearer of great honors from a number of American universities, it is my duty, in view of the slur thus cast upon them, to exact from you that in your next issue you produce these, together with this letter, which, in justice to myself, I am forwarding to other electrical journals. In the absence of such proofs, which would put me in the position to seek redress elsewhere, I require that, together with the preceding, you publish instead a complete and humble apology for your insulting remark, which reflects on me as well as on those who honor me.

On this condition I will again forgive you, but I would advise you to limit yourself in your future attacks to statements for which you are not liable to be punished by law.

(Signed) N. TESLA.

STRAY CURRENTS.

THE IDEAL POWER STATION.

Mr. W. H. Preece read a paper before the Incorporated Association of Municipal and County Engineers at Yarmouth, in which he calls attention to the abuse of the power station. He says the great tendency to multiply power houses arises from (1) want of foresight in predicting the growth of electric industries; (2) economy in selecting land we have rather than pay money for land more suitable by position, but which we have not; (3) the restriction of legislation in confining operations to a defined area; (4) the growth of other industries side by side, especially tramways and railroads worked by electric traction. He also points out that if a plant—say 10,000 k. w.—working at its minimum load on the average three hours a day produces electrical energy at one penny per unit, it will do so at three farthings per unit if it works six hours, one halfpenny per unit if it works 12 hours a day, and less than a farthing per unit if it works twenty-four hours a day. One large station conveniently built on the waterside, where coal can be delivered alongside, by rail or sea, at its cheapest; where water is abundant and available for condensing; where ashes, clinkers and dirt are easily barged away; where we have our control and our staff, is clearly the ideal power house for economy.

A NEW ARC LAMP.

We have been hearing a great deal of late about a novelty in arc lamps. Patents for this kind of lamp have been numerous enough, but it is questionable if there has been anything essentially new in the mechanism of arc lamps for many years. The "Electrical Review," of July 1st, fails to see any novelty in that lamp which has been so much extolled by many of the technical journals lately. Like many other arc lamps, it is regulated by a brake and wheel. No doubt it will work as well as all previous lamps of the same kind and construction, but our contemporary thinks it has nothing specially to recommend it before those already well known to purchasers and electrical engineers. The chief advantage claimed for it is that it will be cheaper to make, and presumably to sell, than other arc lamps. If this were true, and any practical advantage could be shown, a demand for them might be expected. There may be something new in attaching the globe of an arc lamp to dashpots, the advantage claimed being that the lamp globe can be raised and lowered by one hand. Of course, that is an obvious advantage in cases where a one-handed lamp-trimmer is employed; but these cases are not numerous enough to promise large dividends. The invention most wanted at present by lamp makers is one to enable them to sell the lamps.

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ELECTRICITY IN JAPAN. In a recent lecture at New York on this subject, Professor I. Fujioka stated that the telegraphic system in Japan, which is controlled by the Government, comprises 12,000 miles of land lines and 388 of submarine cables, besides the cable to Formosa, some 800 miles long. The number of messages sent in a year exceeds 22,250,000, while the traffic with foreign countries reaches 150,000 despatches. The telephone is steadily growing in favor. The first exchange was opened in 1890, and in 1896 there were 540 miles of lines and 3,232 subscribers. Nearly all the larger cities and towns are lighted by electricity, and in Tokio alone there are more than 50,000 lights. The construction of electric street railways has not kept pace with the development in other branches of electrical industry. In Tokio, which has a population of 1,500,000, there are only two working. Although 30 companies recently arranged to take out charters, only two were granted licenses to carry on business. These, however, when their lines are completed, will add an aggregate of 400 miles to the existing tracks.—Ex.

MICROPHONES SUBMARINE TELEGRAPHY. Experiments carried on at Cherbourg on behalf of the Marine Department are said to demonstrate that the pivot microphone is well suited for this purpose. The microphone consists of a carbon disk fixed at the centre of the diaphragm. A number of pivot elements are arranged around the disk. Each consists of a movable part and a little counterweight for regulating the pressure. The pivot is surrounded by a little mercury, which always allows the current to pass without interfering with the free motion of the carbons. This description is not very clear, and nothing is said concerning the way in which the experiments were conducted.—Ex.

CLARIFICATION BY THE ELECTRIC CURRENT. Walthere Spring, the well known scientist of Liege, has addressed a preliminary communication on this subject to the "Chemiker Zeitung." Spring has tried the electric current. When the liquid contains no salts in solution, but only silica, clay, peat, etc., a high electromotive force from 8 to 16 volts is required, as the resistance of the bath is high; in presence of electrolytes, 2 volts will suffice. Spring points out that whenever adhesion is weakened or destroyed, electricity is generated. The fine particles of some emulsions are prevented from coalescing by their electric condition. Electrification causes aggregation and settlement, and the sunlight and heating accelerate the clarification because they give rise to convection and concentration currents.—Ex.

THE MEASUREMENT OF ELECTRICITY. Mr. R. Blondlot, of Paris, recently read a paper on the direct measurement of electricity in electromagnetic units and its application to the construction of a current meter. A coil in the form of a ring is hung on a vertical axis inside a long horizontal bobbin, the same current passing round both coils. The product of the intensity of the current with the time of oscillation—that is, the quantity of electricity which traverses any given section of wire during one swing, is a constant quantity, depending only on the construction of the two bobbins. By the application of a device for counting the vibrations of the small coil, a practical coulomb meter is obtained, which works equally well with continuous and alternating currents.—Ex.

STRAY CURRENT MEASUREMENTS.

Mr. A. A. Knudson, in an article read before the American Institute of Electrical Engineers, entitled "An Electrical Survey in the Borough of Manhattan, New York City," speaks of a series of tests he has made for electrolytic action due to open conduit and trolley roads. He speaks in favor of the open conduit system as causing little or no electrolysis. In his opinion the L road structures, Brooklyn Bridge terminals and the supports of steel frame buildings may be seriously affected in the course of time unless precautions are taken at once to prevent electrolytic action.

Legislation has already occurred in England in regard to this matter and it would seem as though similar municipal action would have its good effect. Mr. Knudson's paper teaches New Yorkers as well as the residents of other trolleyfied cities a valuable lesson—one that may be acted upon at once for the avoidance of serious risks.

WIRELESS TELEGRAPHY.

SOME COMMENTS UPON WIRELESS TELEGRAPHY BY AN ENGLISH CONTEMPORARY.

Our English contemporary, "The Electrical Engineer," of London, thus comments sarcastically upon the present excitement in England over Marconi's invention:

More Marconi.—The untechnical press find in the word "Marconi" an ample word to conjure with, and from the quantity of copy produced we cannot but conclude that the Marconi syndicate helps to keep up the supply. The latest is the rumor of wireless messages to France, and the "Daily Mail" understands that "the French authorities have given permission for signalling stations to be erected anywhere along the French coast, so the experiments will doubtless be put in hand without much delay." In spite of this, and the hope which scientists hold out that signals will be sent without wires from London to Cape Town, the shares of the Submarine Cable Company hold up in a wonderful way. We fancy that the hopes of a large and successful company flotation are the main cause of much of the vague and rosy information disseminated about Marconi. To quote Mr. W. H. Preece's recent address before the Institution of Civil Engineers: "Sensational experiments for booming a new financial enterprise are not processes that commend themselves to the institution. We want practical work and engineering progress.'

CONDUCTORS.

ALUMINUM WIRE.

Aluminum wire, says the "Electrical Engineer," will be used for the transmission line conveying 10,000 horsepower from Snoqualmie Falls to Seattle and Tacoma, Washington. Contracts have been made for the supply of the wire—150,000 lbs.—at prices that make it cheaper than copper for the purpose. The metal used will be nearly pure, being guranteed to contain 99.30 per cent. of aluminum and not more than 0.25 per cent. of iron and 0.30 per cent. of silica. It will be alloyed with 1.50 per cent. of pure copper. This is the first large transmission to use aluminum, and marks an important step in electrical engineering; for while aluminum has been talked of for some time for this purpose, price or some other factor seems to have stood in the way of its practical use to any extent over long distances. For the first 20 miles the transmission lines will run over the same right of way. At Renton they separate, and one goes northwest about 12 miles to Seattle, while the other goes southwest about 27 miles to Tacoma. At Renton there will be facilities provided for switching the Seattle circuit on to the Tacoma circuit, and *vice versa*.

Paducah, Ky.—Henry Biedeman is organizing a company to install a telephone system.

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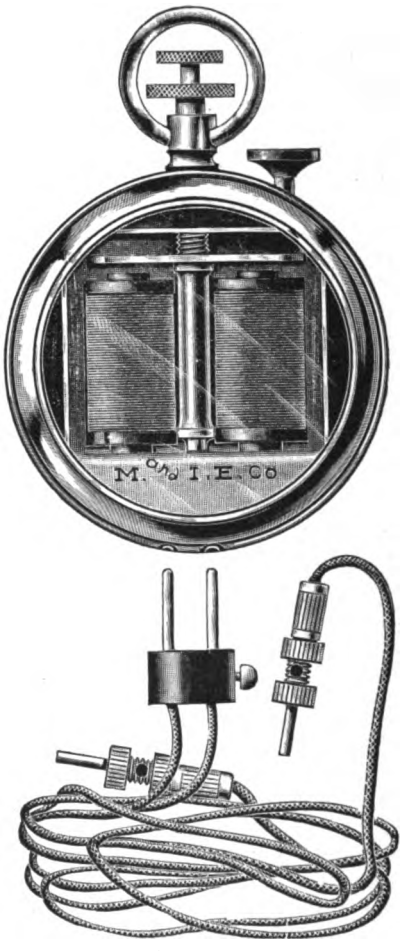
TELEGRAPHY.

THE COMBINATION MORSE WATCH,

That is, a Morse-Watch combined with key, is exactly similar to the Morse-Watch with the addition of a thoroughly practical, platinum-pointed telegraph key mounted in the same case. With exception of knob, the whole key is inside the case. The knob is hard rubber mounted conveniently for work, but offers no obstruction to putting the watch into or removing it from the pocket. The "play" of key is adjustable by turning the knob, and turning the knob solidly home makes a positive circuit closer. The whole is neat, compact and workmanlike.

Identification.—Each instrument, "Morse-Watch" and "Combination Morse-Watch," is numbered individually.



In writing the manufacturers or dealers at any time with reference to any instrument in the purchaser's possession, invariably give the number of the instrument referred to, for its identification.

Weight and size.—As stated, the size of the Morse-Watch is the popular standard watch size No. 18. The weight of the whole equipment, watch, cords, tips, headband and all, is 4½ ozs., and goes packed in a space 1 inch deep, 2 inches wide and 3 inches long.

Uses.—For typewriters, train despatchers, railway stations, linemen, testmen, inspectors, bulletin operators, newspaper offices, brokers' offices, military telegraphs, signal service, police stations, election centres, clubs, hotels, and all very noisy locations where it is difficult to hear the ordinary sounder, and all locations where it is desirable to maintain either uninterrupted quiet or absolute secrecy of telegraphic communication.

When used with key it makes a fine pocket or practice instrument. For the latter purpose the M. & I. Electric Co., corner Fulton and William streets, New York, supply two small cells of dry battery in neat pocket form whenever ordered.

ELECTRO PLATING.

SOME POINTS ON GALVANIZING.

At a recent meeting of the London Society of Engineers a paper was read by Mr. Sherard Conzses-Coles, entitled "Protective Metallic Coverings for Iron and Steel." After pointing out the comparative corrodibility of iron and steel under varying conditions, and the importance of the subject now that steel, which corrodes more rapidly than iron, is so largely used for structural purposes and for building light craft, such as torpedo boats, gave some interesting examples of cases where failures had occurred in engineering structures owing to the rapid corrosion of iron and steel. He stated that up to the present zinc had been found to be the most effective coating, which was due to the electro-chemical action set up between the steel and zinc. The author also explained that the electro-chemical action set up between two different metals made it necessary to carefully insulate copper sheathing from the steel hulls of ships, and rendered the direct application of copper valueless as a protecting coating to iron and steel. A short history of the galvanizing industry was then briefly given, together with details of the improvements that had been introduced from time to time. The method of cold galvanizing was then fully described, and the methods of preparing iron surfaces for receiving the coating of zinc. A description was also given of some improvements in the acid treatment and sand blasting for the removal of mill scale preparatory to zincing. The process of sand blasting was fully described. The sand-

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blast apparatus consists of an air chamber and hopper into which the air is forced at a pressure of about five lbs., and projected through a soft rubber fitted with a steel nozzle. It was stated that the harder the surface the more vigorously the small particles of sand or shot attacked it. The question next dealt with was the cost and output of various galvanizing plants, and a description was given of a special apparatus for the treatment of wires and tubes. The author finally explained the best working conditions for electro-zincing, and gave a comparison of the actual and theoretical weight of zinc obtained for a given amount of electrical energy. In connection with the above we note the invention of a new method of galvanizing wire, by which the wire is coated without the necessity of unwinding the coils. The coils or bundles of wire are first cleansed by acid. The whole bundle is then dipped into the bath of melted spelter, and when it has received a thorough coating it is quickly dropped into the basket of a centrifugal machine. For small or light coils the machine may be already in motion, while for heavier wire it must be started after the wire is put in. The surplus coating is almost instantly thrown from the wire, and an excessive speed is not required. The machine is stopped, and the bundle of wire is removed as quickly as possible, and is jarred upon a block to prevent the wires from soldering together. Barbed wire has been successfully treated by the new process after it has been twisted into shape and formed into bundles. When wire is galvanized before being barbed and twisted much of the coating cracks and peels off, and the points quickly rust. Treated by the new process, the wire is said to be more durable. Wire cloth more than eight meshes to the inch cannot be galvanized by the old method, while by the new process cloth of any fineness may be coated, if the speed of rotation is increased according to the fineness.

AN AUSTRALIAN OPINION OF THE MONTAUK MULTIPHASE CABLE.

Extract of Article from the "Scientific Australian," of September 20th, 1898.—"A highly interesting and successful trial of a new fire alarm apparatus was recently given by the maker, Mr. E. H. Kirkby, of Nelson Place, Williamstown, at the head station of the Metropolitan Fire Brigade, Melbourne. The experiments proved that the apparatus fulfils all that Mr. Kirkby claims for it.

"The most interesting feature of the experiments, however, was a trial of the Montauk automatic fire alarm cable, a newly patented American idea. The main instrument was disconnected from the recording apparatus and placed in circuit with the Bouverie street station. A flame was applied to the covered cable for a few seconds and, being thermostatic throughout its length, it was at once set in action and registered a pre-arranged signal at Bouverie street. As a result the hose cart arrived at the head station in under 3½ minutes. This was convincing proof of the usefulness of this cable, in conjunction with Mr. Kirkby's instruments. Had this combination been in use in Elizabeth street, Melbourne, in which the recent great fire originated, there is no doubt but that it could have been confined to small limits The experiments were under the control of Chief Stein and his highly efficient staff of officers, and were an unqualified success.

AMONG THE SOCIETIES.

NEW YORK ELECTRICAL SOCIETY.

The following were elected to membership at the meeting of November, 17, 1898.

Prof. J. Burkitt Webb, Stevens Institute, Hoboken, N. J.
Hubert Greaves Webb, Glen Ridge, N. J.
Henry V. Parsell, 31 E. 21st st., N. Y. City.
Joseph White Stickney, 76 Hicks st, Brooklyn, N. Y.
Augustus Treadwell, Jr., Electric Storage Battery Co., 20 Broad st., N. Y. City.
Morton Arendt, 42 W. 126th st., N. Y. City.
W. G. Burns, 423 W. 117th st., N. Y. City.
Theo. H. Joseph, 32 E. 74th st., N. Y. City.
Bernhardt Hoffman, N. Y. Telephone Co., 15 Dey st., N. Y. city.
W. I. Thompson, 136 Sumner ave., Newark, N. J.
Frank R. Wainwright, Chesley Electric Co., 20 Cortlandt st., N. Y. City.
Thomas J. Buckley, Tenafly, N. J.
St. John P. Chilton, 11 W. 39th st., N. Y. city.
William Newton, Ryerson, Montclair, N. J.
Thomas J. Fay, Eectrical Engineer School of Correspondence, 120 Liberty st., N. Y. City.
J. E. Woodbridge, Editor Electric World, 9 Murray st., N. Y. City.
Charles E. Dustin, Excelsior Electric Co., Brooklyn, N.Y.
Henry B. Cutter, 1112 Sansom st., Philadelphia, Pa.
Alexander McGill, 1190 Madison ave., N. Y. City.
Charles T. Child, Electrical Editor Engineering Magazine, 120 Liberty st., N. Y. City.
Lieutenant W. D. Weaver, American Electrician, 26 Cortlandt st., N. Y. City.
Dr. Louis Duncan, Empire Building, N. Y. City.
A. E. Clifford, American Electrician, 26 Cortlandt st., N. Y. City.
A. Stamm, Chesley Electric Co., 601 Newark st., Hoboken, N. J.
V. C. Gilpin, Cutter Elec. & Mfg. Co., 120 Liberty st., N. Y. City.

Business News.

SPECIAL EXPORT COLUMN.

TOTAL ELECTRICAL EXPORTS FOR WEEK ENDING NOV. 15, 1898, $80,281.00.

New York, N. Y. Nov. 15, 1898. The following exports of electrical material are from the port of New York for the week ending this date:

Argentine Republic—94 packages electrical material, $4,105; 16 packages electrical machinery, $1,319.
Antwerp—53 cases electrical material, $2,149.
British West Indies—30 packages electrical material, $568.
British Australia—93 packages electrical material, $7,719.
Berlin—17 packages electrical material, $789.
Cuba—433 packages electrical material, $1,591.
Central America—9 cases electrical material, $430.
Christiania—4 cases electrical material, $300.
Copenhagen—4 cases electrical material, $83.
Ecuador—8 cases electrical material, $295.
Glasgow—15 cases electrical plates, $300; 7 cases electrical material, $462.
Genoa—10 cases electrical machinery, $350; 1 case electrical material, $111.
Hamburg—30 packages electrical material, $6,458.
Havre—53 cases electrical machinery, $3,162.
London—64 cases electrical machinery, $6,560; 52 cases electrical material, $13,208; 1 case electros, $17.
Liverpool—89 cases electrical material, $4,051; 26 cases electrical machinery, $273.
Mexico—35 packages electrical material, $1,354.
Marseilles—55 cases electrical material, $2,525.
Manchester—6 cases electrical material, $660.
Naples—109 cases electrical machinery, $17,746.

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Odessa—1 case electrical material, $200.
Porto Rico—1 case electros, $10.
Peru—12 packages electrical material, $316.
Southampton—1 case electrical material, $50.
Santo Domingo—76 packages electrical material, $2,451.
U. S. of Colombia—7 packages electrical material, $88.
Venezuela—5 cases electrical machinery, $231.
Wigan—1 case electro shells, $300.
Waterford—1 case electrical material, $50.

POSSIBLE INSTALLATIONS.

Monroe, La.—The Mayor may be addressed regarding the electric light plant which is to be erected. At a recent election $60,000 were voted toward the construction of water works and electric light plant.

Thibodeaux, La.—Address the Mayor regarding the electric light proposition in favor of which the city voted some time ago.

Gadsden, Ala.—The Alabama Light & Power Co. will erect a power plant for furnishing electric railway power; to cost about $25,000.

Kissimmee, Fla.—An election will be held to vote upon granting a ten years' franchise to J. M. Bailey for erection of an electric light plant.

Timmonsville, S. C.—Estimates will be obtained for the construction of water works and electric light plant. Address D. H. Traxler, chairman of committee.

TELEPHONE CALLS.

Charlotte, N. C.—The Queen City Telephone Co. has been organized with the following officers: J. A. Helvin, president; A. G. Brenizer, treasurer; directors, J. A. Helvin, W. F. Steele, R. S. Cole, A. G. Brenizer, T. W. Hawkins, W. H. Steele, J. H. Gourley and T. C. Guthrie; a telephone system is now being constructed.

Mayo, Fla.—The Luraville & Suwanee River Telephone Co. has been incorporated by T. I. McIntosh, S. V. Hough, B. S. Fisher, W. H. Cox, L. T. Boatwright, M. C. Reinck, E. P. Groover, W. T. Dees and M. J. Bryan; capital stock, $3,000; to build, purchase and own telephone lines in Lafayette, Hamilton and Suwanee Counties.

NEW INCORPORATIONS.

Cleveland, Ohio.—International Fac-Similigraph Co. has been incorporated; to manufacture devices for electrical transmission of photograph plates. Capital stock, $25,000.

Macon, Mo.—The Trans-Mississippi Electric Light & Power Co. has been incorporated by F. W. Blees, J. F. Schaefer, of Kansas City, Mo., and C. E. Roel, of St. Joseph; capital stock, $30,000; to establish and erect electric light and power stations.

Waco, Tex.—The Mutual Electric Company has been incorporated by W. S. Seley, S. W. Slayden, I. A. Goldstein and T. Migel; capital stock, $10,000; to supply light and power.

STREET RAILWAY NEWS.

Miami, Fla.—A company will be organized to build an electric line from Miami to Lemon City.

Gadsden, Ala.—The power for the Gadsden & Attalla Union Railway will be furnished by the recently organized Alabama Light & Power Co. The line, which is eleven miles in length, will be rebuilt for the use of electric cars, contracts for which have been given out.

BUSINESS CHANCES.

Baltimore, Md.—There is a movement on foot to combine the Edison Electric Illuminating Co., the Brush Electric Co. and the Northern Electric Co. For further details address J. F. Morrison, manager, Northern Electric Co., 15 South street.

NEW YORK ITEMS.

WILLIAM LINDSAY, formerly with the Pierce Engineering Company, is now connected with the C. & C. Electric Company.

WILLIAM J. CLARK, the well-known manager of the railway department of the General Electric Company, has been requested by Secretary of War Alger to finish the report of the late Col. Waring regarding the sanitation of the principal cities in Cuba.

I. P. Frink, of 551 Pearl street, has published a new catalogue of reflectors, etc., which we would advise those interested in the subject to send for, as it is one of the most complete of the kind. A copy will be sent gratis upon request.

A. L. BOGART COMPANY, 123 Liberty street, have been obliged to double the capacity of their works and sale-rooms, due to increasing business.

F. H. BADGER, JR., and wife, formerly general manager of the Mont Morency Electric Power Company, of Quebec, Canada, is stopping at the Marlborough Hotel.

Mr. STAR, of John Star, Son & Company, Halifax, is stopping at the Imperial Hotel for a few days.

EFFECT OF TEMPERATURE UPON CONDUCTORS.

The investigation of the properties of bodies brought near the absolute zero temperature is certain to give results of extraordinary importance. Already platinum resistance thermometers are becoming useless, as the temperature of boiling hydrogen is but a few degrees from the point where the resistance of platinum would be practically nothing or the conductivity infinite.—Sir William Crookes.

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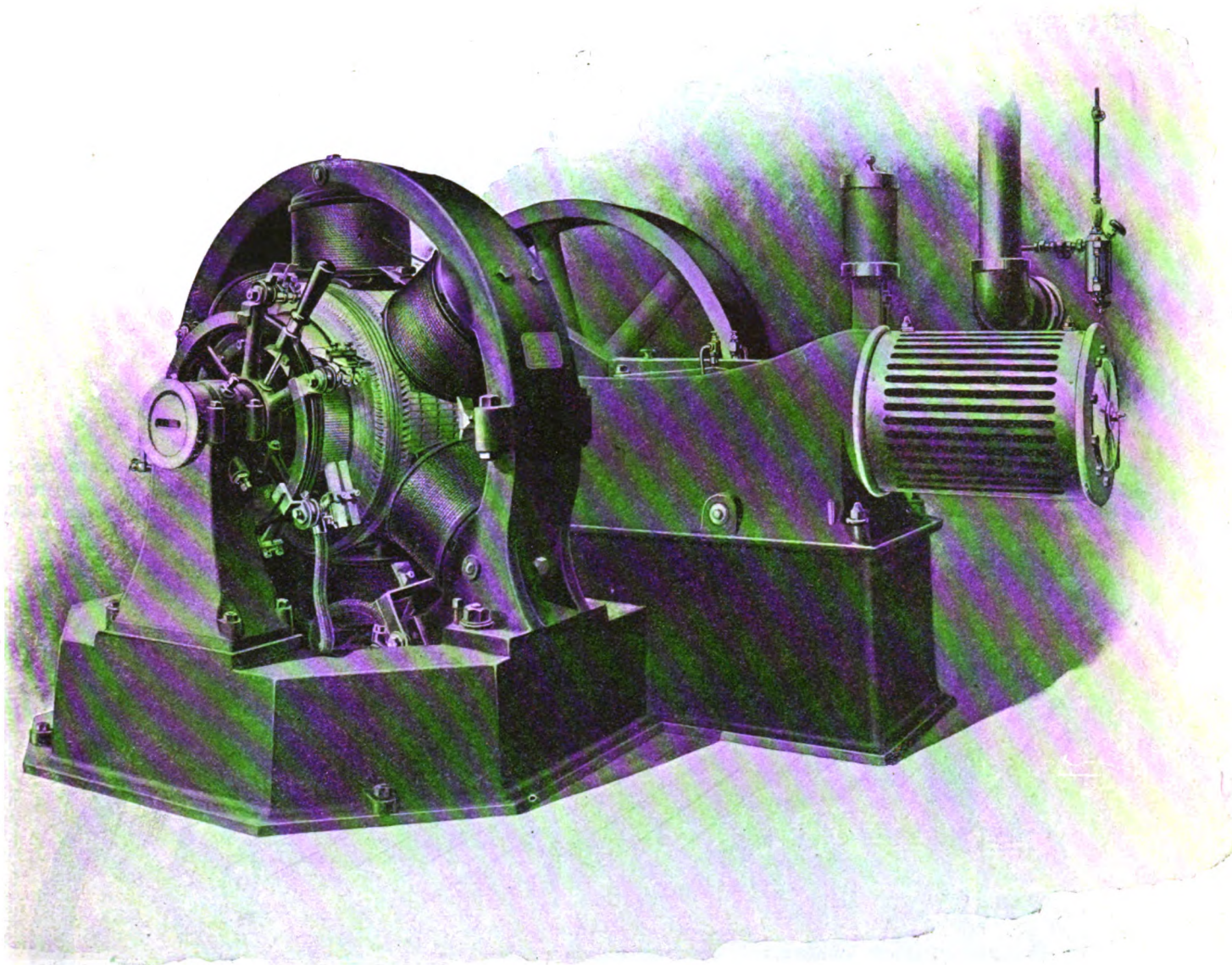
The Electrical Age.

VOL. XXII—NO. 22 NEW YORK, NOVEMBER 26, 1898 WHOLE NO. 602

ELECTRIC LIGHT AND POWER.



Single Cylinder Engine, Direct Connected.

AUTOMATIC CUT-OFF ENGINES FOR ELECTRIC LIGHTING AND POWER PLANTS.

With the development of the dynamo, the engine received attention and underwent improvement such that it took its place as a factor as important as the dynamo itself in electric light and power plants. The design and construction of a successful engine for the above purposes calls for the closest attention to details which cover regulation, efficiency, expansion and other items which, collectively at their best, give issue to a modern engine. For electric light and street railway work, demands of the severest nature are made upon the motive power. It is absolutely necessary that an engine installed to perform its functions uninterruptedly should be one that has passed through a test which uplifts it above criticism. In other words, the modern engine, if it will succeed, must be made from the standpoint of quality, not cost, for herein lies its ultimate success.

The Ball Engine Company, of Erie, Pa., manufacture automatic cut-off engines for electric lighting, electric railway and general manufacturing plants. They have installed their engines, the government of which is unsurpassed in delicacy, in the new Congressional Library at Washington, a building within which everything should be of the best, and the new Public Library at Chicago.

The direct-connected plants driven by the Ball engine possess many advantages. But little floor space is required; there is little or no noise and no belting, the elimination of which means an enormous saving in power in the course of three or four years' service. Instead of there

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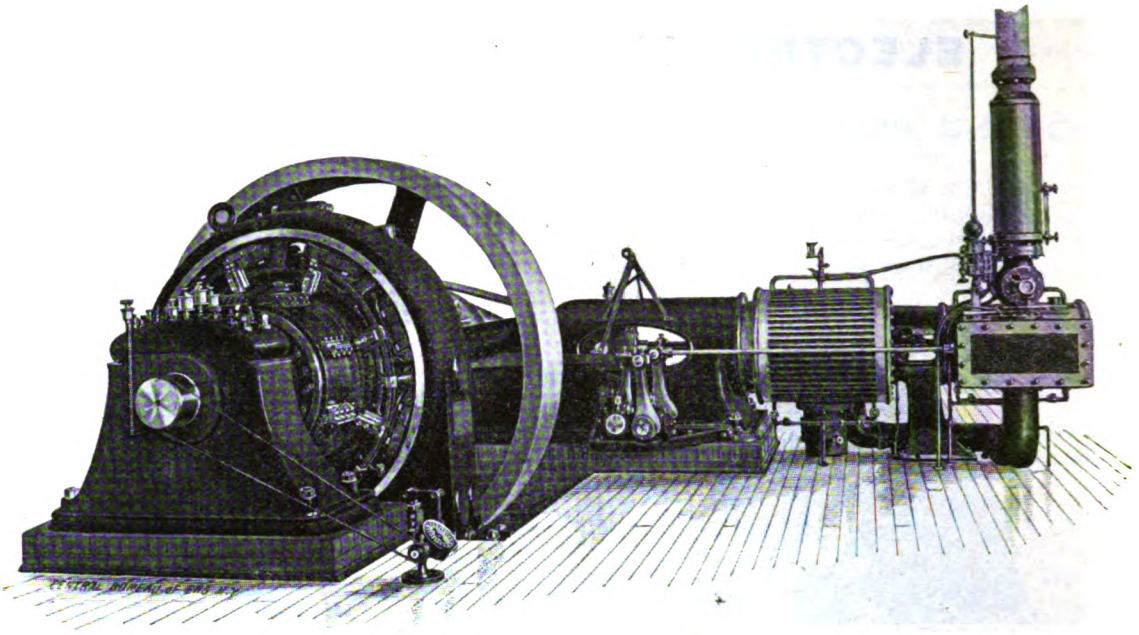
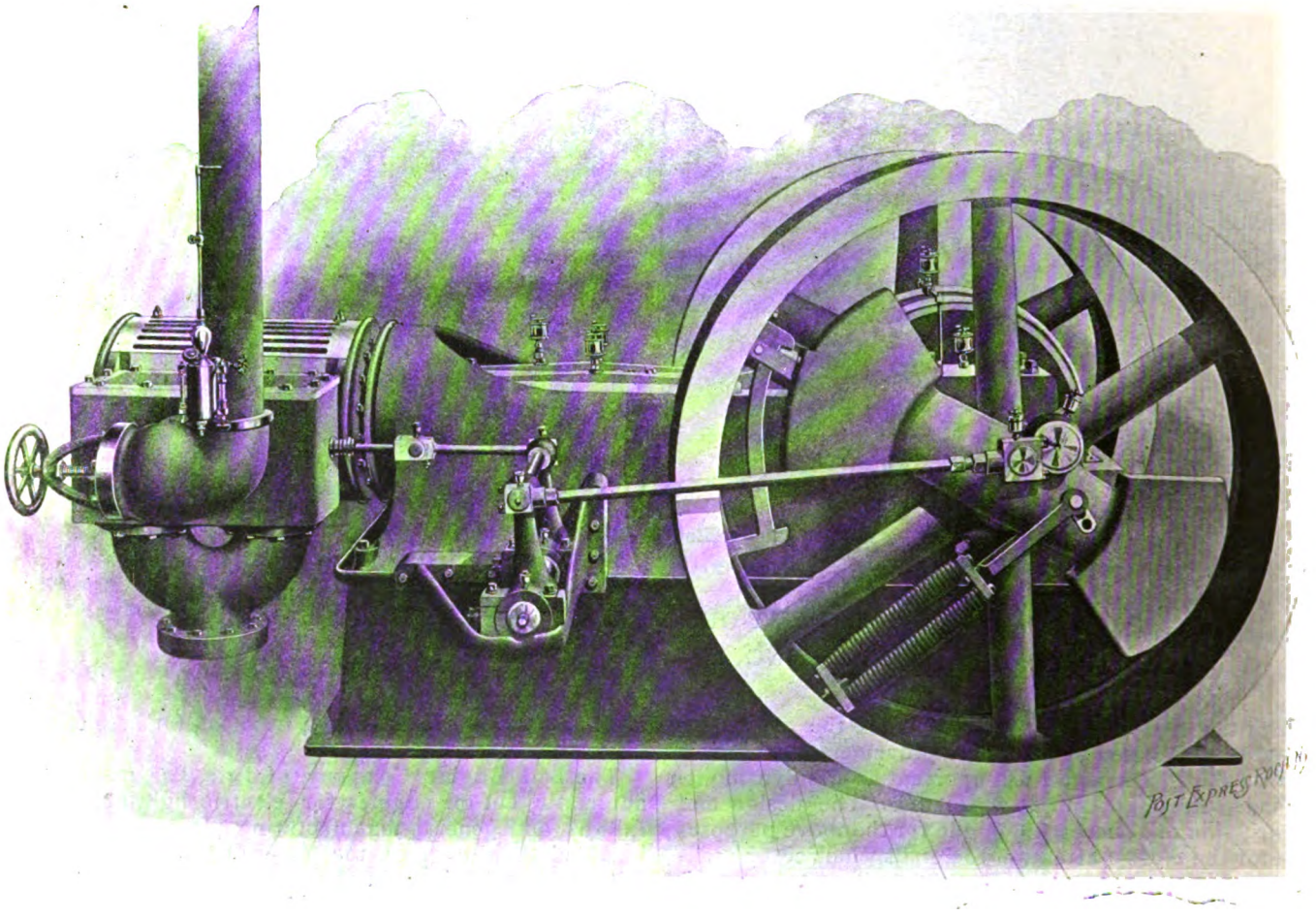
being two widely separated machines to take care of, the dynamo and engine, there is practically one, the lubrication and care of which, though under constant supervision, calls for but a minimum of attention. In buildings each square foot of whose foundation is worth thousands of dollars, a direct-connected plant is the only one ever considered, and through the magnificent regulation, high efficiency and fine exterior of the Ball engine, such plants have become a pronounced success.

The field of electric mining, electric railways and the demands made upon an engine in factory and mill service have always been satisfactorily met by this high-class engine. This problem which comes to the installee of an electric light or power plant is one that is often of the most puzzling character. To those of wider experience a doubt never enters their minds as to whether an engine of the finest quality should be procured or one of inferior construction. The choice of the better is a foregone conclu-



Medium Speed, Side Crank, Tandem Compound Engine—Direct-Connected.



Single Cylinder, Centre Crank Railway Engine.

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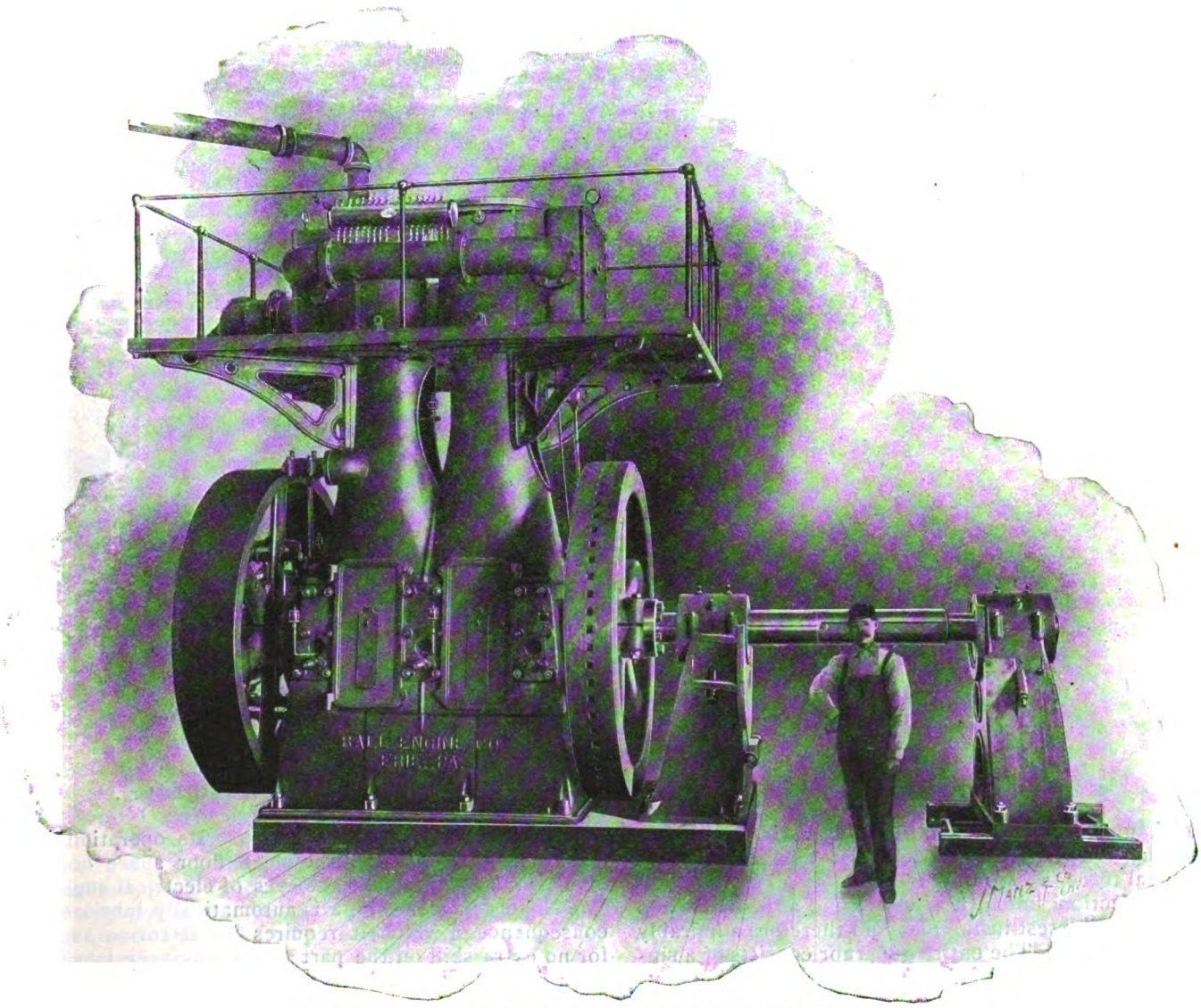
sion, not merely because a high-class engine bears the same relation to an electric light plant that a jewel-bedecked watch might to its happy possessor, but because, as a question of pure finance, there is more money made in the end by buying the best than saved by obtaining an inferior grade. The Ball engine pays a dividend each month to its owner, due to the excellent wear, high efficiency and permanent strength of each operating part.

The Governor.



Vertical Cross-Compound Engine—Arranged for Direct-Connection.

The severe strain of street railway work is admirably met by the single cylinder, centre crank railway engine. The

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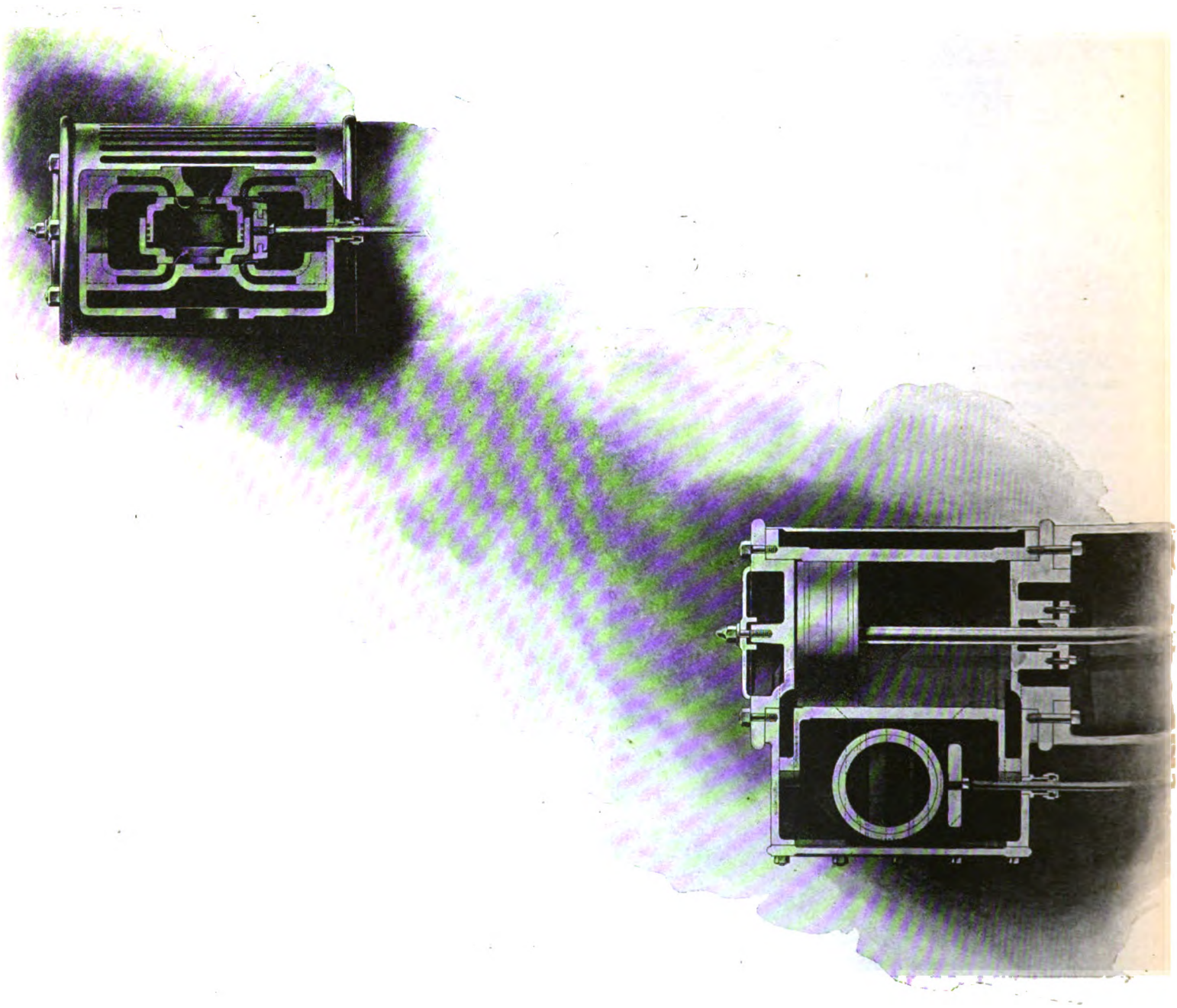
medium speed, side crank, tandem compound engine, direct-connected, is of immense value for electric lighting, whereas this latter type is particularly well adapted for changing loads.

It is certainly evident that an engine able to meet the severest test is of ideal construction for both electric lighting and street railway work. The governor, shown in sketch, the centrifugal element upon which the degree of refinement of all governors depends, is combined with an inertia element relatively so great that instant and extreme changes of load are immediately provided for without waiting for the otherwise necessary manifestations of centrifugal force. It not only regulates to a very high degree of perfection, but with a very rapid adjustment and without the slightest instability, and therefore admirably fulfils the demand. The entire governor consists of a single moving piece suspended upon one pivoted point, thereby reducing the friction to a minimum. The suspension pin, which is of ample size, is made of hardened tool steel. The suspension is lined with frictionless metal, and the little lubrication that is required is accomplished by forcing grease, by means of a compression grease cup, into a number of recesses arranged around the bore of the bushing. The Ball engines are of the single valve type. This valve is perfectly steam tight; this is due to a steam enforced contact alike at all points of the stroke. It is maintained by perfectly smooth surfaces, through which live steam cannot blow into the exhaust during admission or into the port during exhaust. Of the various styles of engines manufactured by the Ball Engine Company, the vertical cross compound arranged for direct connection is the most striking in construction. Its operation is as smooth as possible, and the small floor space occupied gives it immense value in the eyes of electrical engineers. The single cylinder engine is automatically lubricated, in consequence of which it requires no attention and calls for no extra skill on the part of the engineer in charge. Both the vertical and horizontal engines of this company have proved their value on so many occasions in first-class establishments that it is hardly necessary to refer to the long list which the reader, on application, can obtain from the Ball Engine Company's office and works at Erie, Pa.



The Valve.

The Cylinders.

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THE METROPOLITAN TRACTION COMPANY.

For the benefit of such of our friends as are directly interested in street railways, the following extract from an editorial in the "Evening Sun" will show what tremendous power will be possessed by the above corporation on the granting of its franchise. Whether the Metropolitan Traction Company will make full use of its rights in the field of electric light and power remains to be seen. A collision between them and the other companies would be inevitable if such were the case, with the ultimate annihilation or absorption of the weaker. Let us hope that this will not occur. Street railways are very profitable in crowded cities, and the above corporation can quickly earn a larger and better stipend by sticking to traction alone. It will thereby earn the respect and esteem of thousands in Greater New York and of all the generous-minded electrical men the profession is blessed with.

"Within a twelvemonth the Metropolitan Traction Company will be in the full enjoyment of the greatest franchise ever conferred by the City of New York, not even excepting that of the elevated railroad system. It will be engaged in the profitable sale of the electrical current for power and illumination along our great and busy thoroughfare of Broadway, and along every important avenue in New York City, and around the corners of all the streets whithersoever it may choose to penetrate. It is difficult to form any adequate conception of the value of this franchise; it is impossible to overestimate its possibilities of profit and wealth. It is a monument to the genius of William Collins Whitney.

"As the cable takes the place of the horse, electricity supersedes the cable; but electricity does not merely supplant the cable; it reaches out from its subterranean trench to command in one all-embracing grasp what is probably the most profitable and extensive enterprise on Manhattan Island. Early in October the 'Evening Sun' set forth concisely and correctly the fact that this gigantic franchise was in process of acquisition. We showed what was its extent and purpose, and we asked: 'Has no man a word to say? In all this great city is this extraordinary spectacle the concern of not one single taxpayer?'

"It is today beyond recall. The Metropolitan Traction Company and the corporations allied with it are in possession of a franchise from the City of New York which confers a monopoly of the distribution of electricity for power and light.

"*Such are the advantages which they have acquired that those corporations and individuals now supplying electrical power and light within the region of the city will no longer be able to do so as against the new competitor.*

"It will be the greatest wholesale producer of electrical current in the world, and the factor of economy in electricity is not only moving steadily in the direction of greater and greater economy, but has even now reached the point at which the current is produced for power and light at a cost less than the most sanguine dreams of electricians have led them to hope for.

"Entrenched beyond the possibility of competition, with no fears of assault from any quarter whatsoever, the company which Mr. Whitney's genius has wrought to its present greatness is today the greatest mine of wealth, power and authority that ever in history took a vast municipality into its practical possession."

We have but this to say in conclusion: A monopolization of the lighting, power supply and street railway industry by the Metropolitan Traction Company would bring prices down to so low a figure that the general public, "the toiling masses," could enjoy the luxury and advantages the free use of electricity entails. Once let them use it for heating, lighting and cooking at a moderate cost, and the proportions the sale of electricity would swell to would be enormous.

THE CHAIR OF ELECTRICAL ENGINEEEING AT THE McGILL UNIVERSITY.

A Canadian exchange gives some biographical notes of Prof. R. B. Owens, who has been appointed successor to Prof. Carus-Wilson in the W. C. McDonald chair of electrical engineering at McGill University, Montreal. Prof. Owens, who is a comparatively young man, was selected from among the teaching staff of the great universities of the United States. He was at one time connected with the old Baxter Motor Company, but subsequently resumed study under Dr. Louis Duncan at Johns-Hopkins University, Baltimore, and obtained a high standing in mathematics and physics. In 1891 he studied under Prof. Crocker at the Columbia University and obtained the degree of E. E. Nebraska University is indebted to him for some excellent organization work. He was, in 1894, Professor of Electrical Engineering there, and in 1895 he took full charge of the Department of Electrical and Steam Engineering. He was one of the judges of electrical exhibits at the World's Fair. He was recently elected to a Tyndall Fellowship by Columbia University, is a member of a number of American engineering societies, and vice-president of the American Institute of Electrical Engineers.—London Elec. Rev.

Thibodeaux, La.—The Mayor may give information concerning establishment of electric-light plant.

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STRAY CURRENTS.

ELECTRICITY IN THE STOCK YARDS. Messrs. Armour & Co. have determined to utilize electricity largely in place of steam for operating equipment at their various plants. It is stated that the electric apparatus will include machines for supplying 5,000 lights, and other dynamos aggregating 4,800 horse power will be utilized.—Ex.

LONG-DISTANCE TRANSMISSION PLANT. Ten thousand horse power will be transmitted 110 miles to San Francisco if the plans of a company, of which Prince Poniatowsky is said to be the head, are completed, says "Engineering News." It is proposed to utilize the water now running to waste on the western slope of the Sierra Nevada Mountains in Alpine, Amador and Calaveras Counties, constructing a system of canals and a power plant. The transmission line at one place will cross San Francisco Bay with a span about 325 feet above the water. The total cost of the plant is estimated at about $1,000,000.—Ex.

ELECTRIC LIGHTING OF THE PYRAMIDS. Lighting the pyramids of Egypt with electricity and the installation of a 25,000 horse power plant, to cost some $400,000, is a plan now under consideration by the British government, and the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., are reported as likely to receive the contract. As outlined, the plan includes the generation of electric power at the Assouan Falls, on the Nile River, and its transmission a distance of 100 miles through the cotton growing districts, where, it is believed, the cheap power will permit the building of cotton factories. It is planned to use the power to illuminate the interior corridors of the pyramids and also operate pumping machinery for irrigating large areas of desert along the Nile.—Ex.

MAGNETIC STUDY OF IRON. It has long been known by physicists that iron alters in length when magnetized. This phenomenon is made the subject of a special study by Professor Brackett, of Princeton, in "The Physical Review," December. The author treats specially of the effects of tension and of the quality of the metal upon such changes in length in iron wires, and he describes researches made by him at the suggestion of Prof. Rowland, of Johns-Hopkins University. Prof. Brackett believes that the investigation has established the following laws: "Any increase in the magnetic induction tends to lengthen the iron wire; the magnetizing field tends to shorten the wire, and the shortening due to this cause apparently has no limit; the elasticity changes with the induction; .... but the law of the change is unknown, further than that elasticity changes only as the induction changes."—Ex.

THE CENTENARY OF GAS LIGHTING. Electricity has now so largely supplanted the older methods of illumination that people have almost forgotten that this year is the centenary of gas lighting—coal gas having been first applied to economic uses by William Murdoch in 1798, although it was not introduced into London until 1807. In 1825, when meter reckoning came into general use, the rate charged was fifteen shillings per 1,000 cubic feet, subject to a discount of five per cent. for prompt payment. At a later date twelve shillings was charged, and in 1834, three years before Queen Victoria ascended the throne, a further reduction was made, the price becoming ten shillings per 1,000 cubic feet. It is now as low as two shillings and six pence (sixty-two and a half cents) per 1,000 cubic feet in some parts of the United Kingdom.—Ex.

POPULARITY OF AMERICANS IN CHINA. Speaking of the arrival of our new United States Minister at Tientsin, our consul there mentions the general popularity of Americans in China. Expressions of friendship for our people, he says, are heard in official and business circles. He notes a contract just made by a representative of the government with a Philadelphian for the purchase of all machinery necessary to establish an up-to-date woolen mill at Tientsin. The electric machinery will come from the Westinghouse Electric Co.; the boiler and engine from the Harrisburg Foundry and Machine Co., and the remaining machinery from the James Smith Woolen Machine Co., of Philadelphia.—Ex.

PERSONAL. Lord Kelvin has accepted a seat on the board of the Linotype Company, Limited, in succession to the late Dr. John Hopkinson, F. R. S.—Ex.

WATER POWER IN SWITZERLAND IN 1897. "L'Electricien" has recently published some figures upon this subject, and below we give a summary of the more important ones appearing in that paper. During 1897, 35 new projects received the sanction of the authorities, and five extensions of existing installations were also approved. Of the 35 new schemes, 17 were lighting schemes, 4 were transmission schemes, and 14 were combined lighting and transmission schemes. Continuous current was to be used for 14 lighting installations, 1 transmission scheme, and 7 of the combined lighting and transmission plants. The triphase system was to be used in connection with the remaining 13 schemes. Most of the schemes were small, and support the statement that shortly every little village in Switzerland will be lighted and supplied with power for its smaller industries by electricity developed from water power in the vicinity. The total power of the 35 new schemes is made up as follows:

	Kilowatts
27 installations under 100 kw.....	925
6 " 100—500 kw.....	1,324
2 " over 500 kw.....	2,740
Total.....	4,989

This total is 1,758 kw. less than that of the preceding year. The decrease is explained by the fact that all the larger and more easily developed waterfalls have already been exploited.—London Elec. Rev.

WIRELESS TELEGRAPHY.

LIGHT ELECTRIC TELEGRAPHY.

Professor Zickler, of Brunn, has conducted an elaborate series of experiments which show that a telegraphic instrument can be actuated at considerable distances by a beam of ultra-violet light. He employs a powerful arc lamp as his transmitter, using a screen of glass to produce intermittent flashes of the ultra-violet beam, which embody themselves as dot and dash signals on his receiver. The receiver is an air-gap in a circuit containing an induction coil regulated to an electromotive force just below the sparking point at the air-gap. As Hertz long ago has shown, a beam of ultra-violet light falling on the cathode of a strained air-gap near its breaking-down point, will immediately provoke a discharge.—Ex.

Charlotte, N. C.—The Queen City Telephone Co. has been organized with J. A. Helvin, president; A. G. Brenizer, treasurer.

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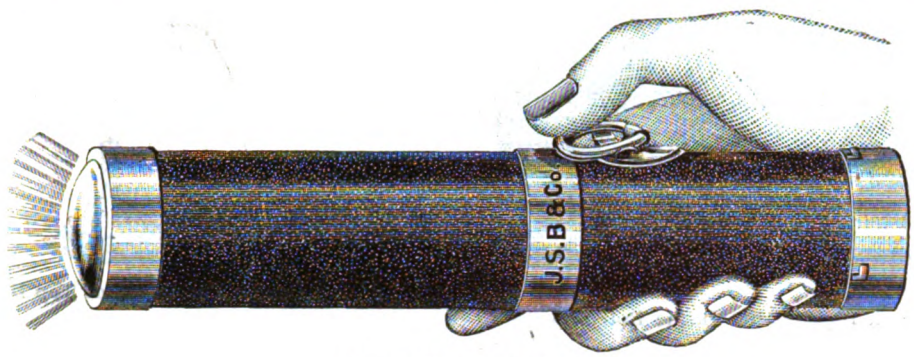
ELECTRICAL NOVELTIES.

A NOVEL ELECTRIC POCKET LAMP.

The risk of life and danger from fires due to the striking of matches is very great in large cities. In many establishments where combustible material and explosive chemicals are manufactured and handled, exposed flame, such as gas, candle, oil lamp or match will produce, is strictly tabooed. An absolute demand has arisen for a safe illuminant, a source of light which incurs no risk by its use. The new pocket electric light manufactured by James S. Barron & Company, manufacturers of, and wholesale dealers in, general electrical supplies, 24–30 Hudson street, New York City, possesses all the features required to make it safe and reliable. It is the most serviceable electric light on the market and is self contained. There are no wires to get out of order and no chemicals to spill. It can be placed in the midst of gas or gunpowder; in fact, where no other light can be used, with perfect safety. There are no odors, and it is always ready. If placed under the pillow at night, it may be immediately used for seeing the time.



Pocket Electric Light.

As regards its portability, the illustration shows it one-half its real size. Its weight is insignificant and the light it throws out comparable to a miniature search. Three cells of battery within the case supply power to the lamp. It will light as long and as often as six thousand matches and costs considerably less. When the batteries deteriorate, which takes a very long while, they are renewal le at slight expense. The pocket electric light will, with use, become an indispensable article to people in all walks of life.

RYDER'S ELECTRICAL SPECIALTIES.

In an article published in the New York "World" of July 3, 1898, entitled "Does Electric Light Affect the Brain?" the injurious consequences of having the glare of an electric light strike the brow of a person uninterruptedly, as shown in Figure 8, are described and the evidence of a large number of eminent physicians and surgeons fully bears out this statement. In a large number of cases it was found that loss of sight, dullness of vision, brain fever, etc., were caused by electric light falling directly upon the forehead, as shown in the illustration. In order to overcome this evil there has been a great number of devices invented for the purpose of diffusing the light and reflecting it directly upon the work of the artist, editor, author, book-keeper, merchant, banker, etc., and thus keeping it away from the eyes and head.

Messrs. A. H. Ryder & Company, electrical engineers, of 180 Broadway, New York City, have been experimenting for a number of years upon devices for diffusing and softening the rays of electric light for use in offices, etc., on roll and flat-top desks, etc.

The following illustrations give an idea of the success of the Ryder specialties in desk and table lamps. Figure 1 shows the Ryder desk lamp applied to the inside of a roll-top desk, it being the only light made with an attachment to fit any roll-top desk, which can be folded down when not in use and allow the desk to be closed, thus keeping out dust and dirt which naturally accumulates on exposed desk lamps. The Ryder specialties have an adjustable arm, allowing the light to be thrown in any direction desired. The Ryder lamps are all corrugated and white enamelled on the inside, enabling them to cast a most brilliant reflection. The eye-shade is easily adjustable to suit.

All cylinders of the lamp proper contain an ingenious device for holding the lamp socket in place and for adjusting it to any make of socket. They make in this general design a number of lamps, as shown in Figures 4 and 5, for roll top and bookkeepers' desks and in portables, as shown in Figures 2 and 3. Special attention is called to Figure 2, showing a double portable, which can be taken apart and placed in one of the Ryder handsome cardboard boxes for shipment to all parts of the world.

Fig. 8.

All of their lamps are kept in these boxes for shipping and shelving in supply houses, etc., thus permitting no dust or fly specks to reach them, keeping them bright and clean at all times.

All these various styles of desk and portable lamps are interchangeable or adjustable to all the attachments of the Ryder lamp. Figure 6 shows the lamp fixed to a side wall; it can be swung in either direction, and is made to meet requirements where desk lamps can not be used. Figure 3 shows a single portable for flat top desks, etc. Like the double portable, it can be raised or lowered or swung in any position desired.

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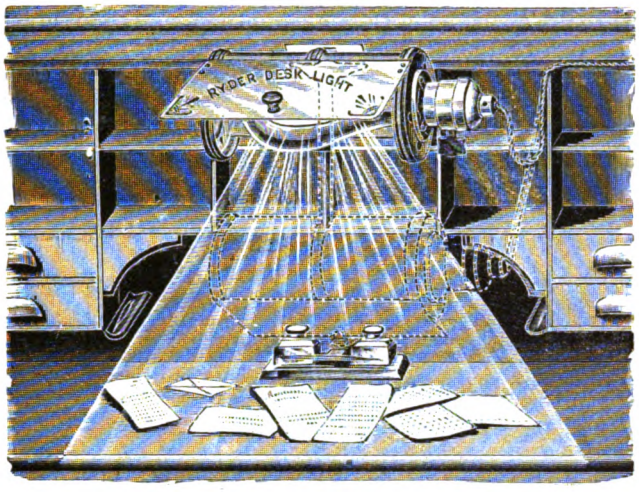

Fig. 1. The Ryder Desk Light shown Inside Roll Top Desk.

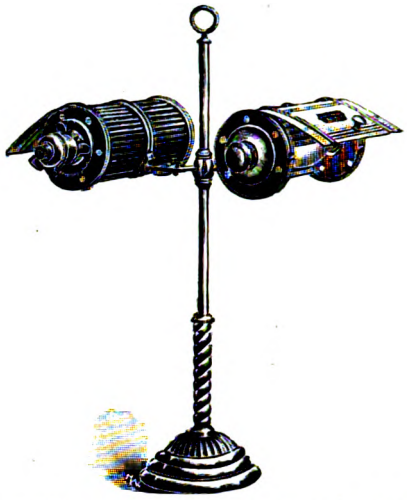

Fig. 2. Double Portable Flat Top Desk or Table Lamp.

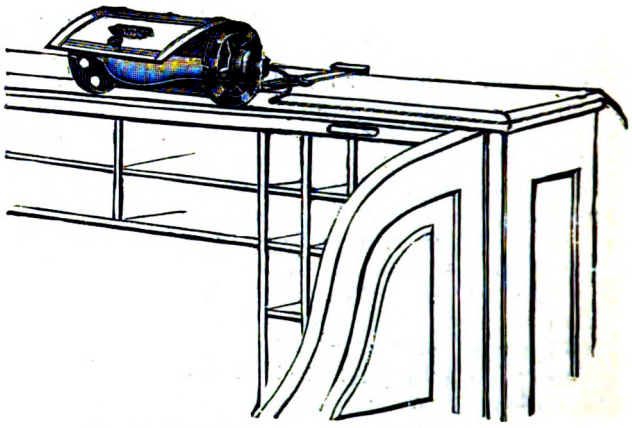

Fig. 4. Top Attachment on Roll Top Desk.
Made to fit all styles of roll top desks, add interchangeable with all other styles of Ryder's attachments.

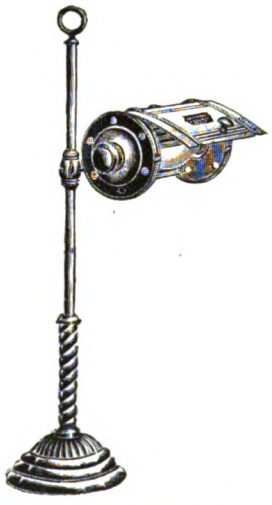

Fig. 3. Single Portable for Flat Top Desks, etc.

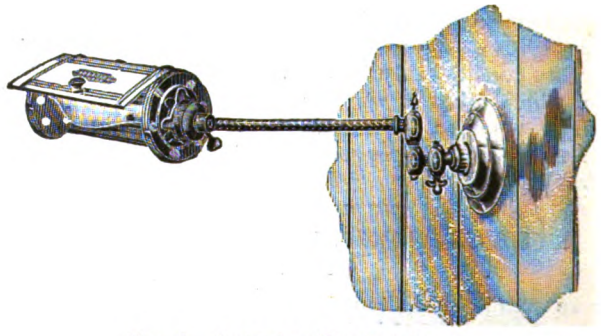

Fig. 6. Swinging Bracket Lamp.

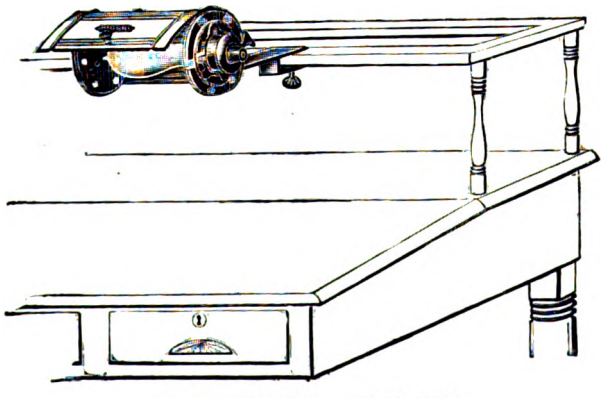

Fig. 5. Bookkeepers' Upright.

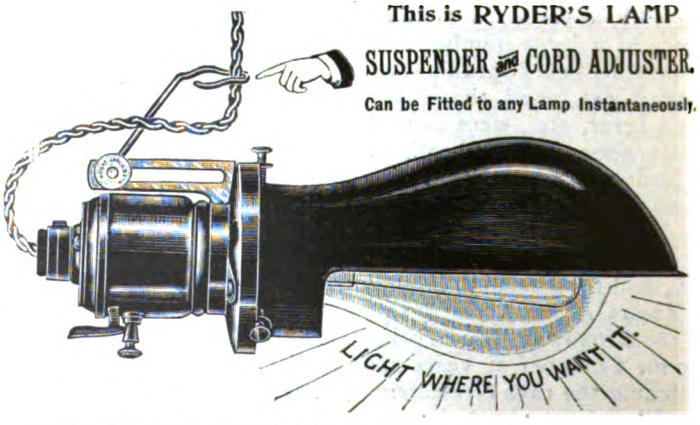

Fig. 7. Cord Adjuster Attached to Lamp with Aluminum Half Shade. Can be set to any height and adjustable to any position.

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Particular attention is called to Ryder's special lamp, which can be used with any of their desk or portable lamps, and is the only desk lamp which you can regulate and soften the light, if desired. Figures 7, 8 and 12 illustrate Ryder's lamp suspender and cord adjuster attached to an incandescent lamp with aluminum half shade. The adjuster can be fitted to any style of incandescent lamp and socket, and permits the

Fig. 12. Lamp Suspended on Cord Adjuster.

lamp to be raised or lowered and takes the strain off the connecting screws inside the lamp socket. A slight turn of the thumb nut, shown in this attachment, unlocks the universal joint and allows you to place the lamp at any angle desired instantly. Figure 11 illustrates the difficulty and obstacles met with in the old style cord adjuster. Figure 12 illustrates the convenience of the adjuster in allowing the lamp to be placed at any angle desired. Figure 10; this man has no time to spare; he can adjust the lamp without getting up out of his chair.

A. H. Ryder & Company will send full and explicit directions with illustrations showing how to put up any of their specialties. Prices and discounts will be sent on application. They will call and install any of their specialties in this vicinity, as they are expert wiring contractors.

Fig. 10. The New Way.

Fig. 11. The Old Way.

Fig. 12. What Brownie Saw.

CONDUCTORS.

SUCCESS OF ATTIX WIRE.

Attix electric light wire had a long fight for recognition and it was only through persistently keeping up his demands that the inventor, Mr. Thomas F. Attix, a prominent electrical engineer of 283 Flatbush avenue, Brooklyn, was finally successful. In January, when the Building, Lighting and Supply Department of Greater New York took charge of the inspection of wiring, they passed upon Attix wire and allowed its installation in all buildings where circular loom tubing can be used. This wire is water and fire-proof in the highest degree, being first covered with the best grade of Habirshaw, standard red core insulation, then braided, and after this covered with a water-proof tube. Covering the whole is a fire-proof tube, made of a secret composition, and guaranteed to be flame proof.

Attix wire, with its fire and water-proof covering, costs less than rubber wire run in flexible tubes or iron conduit, and is a much better safeguard, there being no air space left between the rubber and tube. Attix wire installed over six years ago is just as serviceable today as when first

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put in service. Not one foot of Attix wire has had to be removed since its installation, a proof of the good qualities of the same. No taps are allowed on this wire, all wires being run on the loop system.

Six years ago Prof. Morton made the severest kind of tests ever made before or since on any kind of insulation, and found that Attix wire came fully up to the standard. One of the tests was allowing it to remain in wet mortar for a long period, through which ordeal the wire passed successfully.

EXPOSITIONS.

1899 ELECTRICAL SHOW.

At the annual meeting of stockholders of the Electrical Exhibition Co., held Monday evening, November 21st, 1898, it was unanimously decided to hold another electrical exhibition in New York City in 1899.

The following offieers and directors were elected:

C. O. Baker. Jr., president; F. W. Roebling, vice-president; Geo. F. Porter, secretary and treasurer; H. H. Harrison, L. F. Requa, J. W. Godfrey, C. A. Lieb; Marcus Nathan, general manager.

CANADIAN ELECTRICAL NEWS.

ELECTRIC LIGHTING IN CANADA.

St. Thomas, Ont.—It is understood to be the intention of Mr. J. H. Still to rebuild his handle factory. It is probable that the pipe foundry will be rebuilt. The People's and the Bell Telephone Companies will be asked to submit new propositions for a telephone franchise.

Levis, Que.—At the next council meeting the question of introducing waterworks and electric light systems will be discussed. The project, if carried out, will cost from $200,000 to $300,000.

London, Ont.—The People's Telephone Company, according to report, intend to install a plant here at once. They will purchase their supplies from the Stromberg-Carlson Manufacturing Co., of Chicago, who will likely start a factory here.

Hamilton, Ont.—Mr. Percy Domville has been instructed to prepare an estimate of the cost of an electric lighting plant of 300 arc and 3,000 incandescent light capacity by the Electric Light Committee.

Toronto, Ont.—The Toronto Electric Light Co. and the Metropolitan Railway Co. have submitted tenders for the electric lighting of the village of Deer Park.

Hull, Que.—Tenders for lighting the city by electricity will shortly be invited.

Seaforth, Ont.—It is understood that a company is being formed to operate a telephone exchange here.

Victoria, B. C.—The Electric Light Committee have recommended that city invite tenders for twelve arc lamps and half a mile of electric wire.

North Sydney, C. B.—Mr. J. A. Young, of the Sydney Gas and Electric Co., has floated the Glace Bay Electric Light and Power Co. for the purpose of supplying electric light to the village of Glace Bay. The power house will be located at the abandoned Stirling pit.

Ingersoll, Ont.—The town council have appointed a committee to negotiate for the purchase of the waterworks and electric light plant and to arrange for the construction of a main sewer on Thames street.

Beeton, Ont.—The contract for an electric light plant for the town having been given out, steps will be taken at once to build a power house and to purchase an engine and boiler.

Ottawa, Ont.—The Deschenes Electric Co. will, it is said, make another application to the city for a franchise for electric lighting and power.

J. ALCIDE CHAUSSÉ.

ELECTRIC RAILWAYS IN CANADA.

Hull, Que.—The question of extending the Hull & Aylmer Electric Railway to Gatineau Point is under consideration of the directors. It is the intention to commence the construction next spring. At the last meeting of the city council it was decided to call at once for tenders for lighting the city by electricity.

Three Rivers, Que.—In connection with the water power of the Shawenegan Falls, on the St. Maurice River, the contract for hydraulic work was let to Messrs. Barry, Ross & McRae, of Niagara Falls, Ont. It is probable that the scheme will include the construction of an electric railway from Shawenegan Falls to Three Rivers, a distance of 19 miles.

Quebec, Que.—An official announcement has been made by the Quebec, Montmorency & Charlevoix Railway Company that it is proposed to electrify the road that runs to Cap Tourmente and construct an independent line to Montmorency Falls. The estimated cost is given at $330,000, and when completed will comprise over 60 miles of electric railway. Mr. H. J. Beemer is president of the company.

Sarnia, Ont.—A meeting of the Railway Committee of the town council with the representatives of the Lambton Central Railway and the Sarnia Street Railway relative to the proposed suburban line.

Bridgetown, Ont.—A meeting of gentlemen interested in securing an electric railway between Thamesville, Bridgetown and Rondeau Park was held here last week, at which it was decided to apply for a charter as soon as the necessary funds could be procured. Among those present were Mr. R. Ferguson, M. P. P., and Mr. W. E. Gundy.

Victoria, B. C.—In behalf of a Victoria syndicate, Messrs. W. Jenson and S. Goodacre give notice of application for the incorporation of the Hardy Bay Tramway Co. to build a tramway from Hardy Bay to Cold Bay, Quatsino Sound, a distance of eight miles. It is probable that electricity will be the motive power.

Toronto, Ont.—The Toronto Street Railway Company is considering a scheme for radial electric railways throughout the province, with Toronto as headquarters. The company have not yet, we learn, reached any decision in the matter.

Cornwall, Ont.—It is understood that some improvements will be made to the system of the Cornwall Electric Railway Co., of which D. A. Starr is manager.

Hamilton, Ont.—The promoters of the Hamilton, Chedoke & Ancaster Electric Railway have made a new proposition to the city council, which has been accepted. It is hoped that now it will be possible to finance the project.

Hamilton, Ont.—The Hamilton Radial Railway Co. has decided to extend its line from Burlington to Port Nelson. Operations on the construction will be commenced immediately, it is said.

St. Thomas, Ont.—It is probable that the St. Thomas Street Railway will be extended to Port Stanley. J. H Still is president.

J. ALCIDE CHAUSSÉ.

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OBITUARY.

LATIMER CLARK.

Latimer Clark, C. E., F. R. S., the inventor of the standard cell, died October 30th, at Twickenham, England. Mr. Clark was born in 1822, and is best known through his paper, read in conjunction with Sir Charles Bright, presenting a definite system of electrical measurement in ohms, volts and farads, this practically forming the basis of modern electrical scientific measurement. Mr. Clark was actively connected with many submarine telegraphic enterprises, and also introduced a number of improvements in telegraphy.

Business News.

SPECIAL EXPORT COLUMN.

TOTAL ELECTRICAL EXPORTS FOR WEEK ENDING NOV. 22, 1898, $100,971.00.

New York, N. Y. Nov. 22, 1898. The following exports of electrical material are from the port of New York for the week ending this date:

Antwerp—20 cases electrical material, $2,097.
British East Indies—14 packages electrical material, $400.
British Australia—28 cases electrical material, $1,355.
Berlin—4 packages electrical machinery, $872; 2 cases electrical material, $50.
Brazil—179 cases electrical material, $5,258.
Bremen—5 cases electrical material, $375.
Brussels—3 cases electrical material, $65.
British West Indies—71 cases electrical material, $3,004.
Cuba—18 cases electrical material $703.
Central America—1,632 packages electrical material, $3,934.
Frankfort—1 case electros, $10.
Hamburg—11 packages electrical material, $2,262; 56 packages electrical material, $2,867.
Hayti—3 cases electrical material, $33.
Havre—106 cases electrical material, $17,877; 68 cases electrical material, $3,852.
Liverpool—18 packages electrical material, $1 253; 70 packages electrical machinery, $3,389.
London—115 packages electrical material, $3 510; 150 cases electrical machinery, $38,293.
Leeds—6 cases electrical material, $221.
Mexico—2 cases electrical machinery, $167.
Marseilles—14 packages electrical material, $1,500.
Munich—2 cases electrical material, $29.
Nova Scotia—2 cases electrical material, $22.
Naples—82 cases electrical machinery, $3,050.
New Zealand—24 cases electrical material, $592.
Newfoundland—3 packages electrical material, $38.
Newcastle—29 packages electrical machinery, $3,000.
Venezuela—1 package electrical material, $53.

STREET RAILWAY NEWS.

Louisville, Ky.—It is proposed to build an electric railway from Louisville to Power Valley, a very large suburb of this city.

Lansing, Mich.—The Long Lake, Durand & Corunna Railroad Co. has been organized to build a line through Shiawassee and Genesee Counties. Capital stock, $50,000. The line will be operated by electric power, with Owosso as the central station.

New York, N. Y.—The Fort George Extension Railway Co. has been incorporated to operate an electric line on Eleventh avenue, from One Hundred and Seventy-second street to One Hundred and Eighty-fifth street. Capital stock, $10,000.

Gadsden, Ala.—The Alabama Light & Power Co. will build a power plant, to cost $25,000, to furnish electric-railway power, etc.

TELEPHONE CALLS.

Blissfield, Mich.—The Blissfield Telephone Co. has been incorporated with a capital stock of $3,000.

Toledo, Ohio.—The Montpelier Telephone Co. has been organized with J. S. Bradley, manager. A local exchange will be operated in a month.

Cleveland, Ohio.—Interstate Telephone Co. has been incorporated with a capital stock of $25,000.

Bryan, Mass.—Williams County Toll Line Co. has been incorporated to operate telephone line. Capital stock, $30,000.

New Bedford, Mass.—The Automatic Telephone Co. has been organized with a capital stock of $100,000. The company will immediately commence the construction of a first-class underground system, with private metallic circuits for each subscriber.

Grand Rapids, Mich.—Fuller & Perkins are organizing a stock company to establish a complete telephone exchange to cover Mason, Oceana and Manistee Counties.

Paducah, Ky.—Henry Biederman, who recently obtained telephone franchise, is organizing a company to install system.

NEW INCORPORATIONS.

New York, N. Y.—Newton Appliance Co. has been incorporated by Jas. A. Stiles, David E. Drake, Louis Heck, Chas. L. Eidlitz and B. F. Hamilton; to manufacture electrical specialties. Capital stock, $25,000.

Grand Rapids, Mich.—The Newaygo Transmission Co. has been organized by local capitalists, with $15,000 capital, to develop the water power at Newaygo and to transmit electric power to this city.

Newark, N. J.—The Electric Motor and Equipment Co. has been incorporated by Augustus J. Miller, Jos. G. Ward, Jr., and Frederick G. Agens, Jr.; to deal in, operate, manufacture, repair, etc., electric motors and electric machinery. Capital stock, $100,000.

Caro, Mich.—Caro Light & Power Co. has been incorporated, with a capital stock of $25,000.

Chicago, Ill.—National Electric Trades Association has been incorporated.

Chicago, Ill.—Gregory Electric Co. has been incorporated by C. A. Gregory, G. A. Fargher, G. K. Wadsworth. Capital stock, $100,000.

Pierre, S. D.—The Chemical Battery, Light, Heat and Power Co. has been incorporated by Frank W. Lowery, E. L. O. Apel and E. L. Squire. Capital stock, $5,000,000.

Waco, Tex.—The Mutual Electric Co. has been incorporated by W. S. Seley, S. W. Slayden, I. A. Goldstein and Tony Migel; to supply light and power. Capital stock, $10,000.

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NEW YORK ITEMS.

Francis Granger, the agent for the Corning Brake Shoe Company, now at 35 Nassau street, will remove to No. 26 Cortlandt street on December 1st. Mr. Granger is also agent for the Orient Electrical Company, Youngstown, O., manufacturers of all styles of incandescent lamps for railway and commercial purposes. Mr. Granger found it necessary to move to larger quarters owing to the growth of his business, and will be pleased to welcome his friends at his new address.

The Cherry Electric Works, 25-27 Third avenue, manufacturers of the Cherry ampere and voltmeters, are in receipt of many flattering testimonials from users of their instruments, among them being letters from the Hanson & Van Winkle Company, Newark, N. J.; the Electric Self-Playing Piano Co., city; the Manhattan Electrical Supply Co.; M. R. Rodrigues, Brooklyn, and others. These instruments have met with great favor ever since their introduction, owing to the care and attention bestowed upon their manufacture, thus assuring accuracy and reliability.

Mr. Ernest A. Lowe, manager of J. Jones & Son, the well known electrical supply dealers, of 64 Cortlandt street, has returned to his duties after a severe and prolonged attack of rheumatism. Mr. Lowe has been greatly missed by his many friends in the trade and the many customers of the firm. We congratulate Mr. Lowe upon his return to his labors and hope that he will be speedily restored to his old-time strength and vigor.

The Yaryan Company, Times Building, are the eastern agents for the Frontier gas engines, especially adapted for electric light plants. These gas engines are made with two cylinders, tandem type, giving an impulse with every revolution. The Yaryan Company also handle the Yaryan multiple effect evaporators, grinding mills, special machinery, etc.

Goldmark & Wallace, 121 Worth street, are receiving orders for their well known Koch woven wire tube dynamo brushes from every State in the Union, the users of the same speaking in the highest terms of the good qualities of the brush.

Chester Cullingworth, eastern sales agent for the E. S. Stiles Press Co., 243 Centre street, is a young and energetic salesman. Mr. Cullingworth carries a large stock of presses and takes orders for presses for all classes of work. He has had an extended experience in the various departments of machinery manufacturing establishments, having graduated from the draughting department of one of the largest manufacturers in the country.

The Leclanche Battery Company, 111–117 East 131st street, the original manufacturers of Leclanche batteries in this country, have prepared a valuable little brochure of their batteries. This brochure contains valuable information for the electrical engineer and will be mailed, postage prepaid, on request to the above company.

Readers of the "Electrical Age" will find it to be to their benefit to write Charles J. Bogue, 215 Centre street, for descriptive circulars of his new American enclosed arc lamp, which is the superior in many qualities of any arc lamp now on the market.

Mr. Wildey, of 23 Duane street, is bringing out some useful holiday novelties, among them being a small kinetoscope run by a small motor, to be sold at a low figure. Write to the above address for further details.

The St. James Electric Company, 1133 Broadway, have brought out a very interesting novelty. It is a big seller, selling on sight, and we would advise our readers to write for circulars of the same.

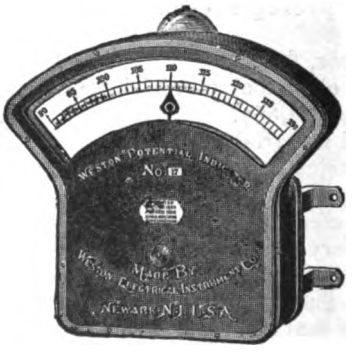
Stein & Langlos, manufacturers of electrical goods for the trade, 220 Centre street, have doubled their floor space, preparatory to meeting the demands of the trade. Write for circulars of their special inventions.

Baker & Fox, 83 Schermerhorn street, Brooklyn, have brought out an ingenious form of focussing lamp, made for either hand or automatic feed. They will send description of the same, together with circulars of the Fox photo-engraving lamps, theatrical effects, etc., on request.

H. B. Coho & Company, agents for the Eddy Electric Company, manufacturers of dynamos and motors, have opened up new offices at 143 Liberty street.

W. C. VOSBURGH MANUFACTURING CO., Limited, 269–281 State street, Brooklyn, the well-known gas and electric-light fixture manufacturing concern, have just issued a new No. 20 electric catalogue which will be sent free to responsible dealers upon request. Dealers having received a copy of the catalogue speak of it in the highest terms and say that it is the most complete book of its kind issued so far.

WESTON STANDARD ILLUMINATED DIAL



STATION INSTRUMENTS.

THESE INSTRUMENTS are based upon the same general principle and are just as accurate as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger, and the working parts are inclosed in a neatly designed dust-proof cast-iron case, which effectively shields the instruments from disturbing influences of external magnetic fields.

WESTON ELECTRICAL INSTRUMENT CO.

114-120 William St., Newark, N. J., U. S. A.

"VULCAN" AND

"INDEPENDENT"

STYLO AND FOUNTAIN PENS.

SEE OUR ADV. NEXT WEEK.

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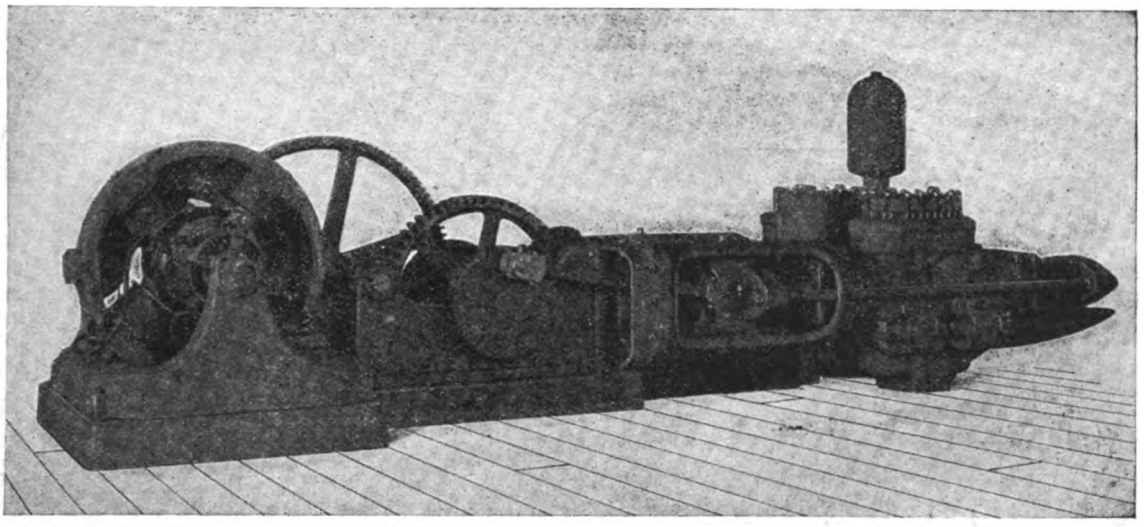
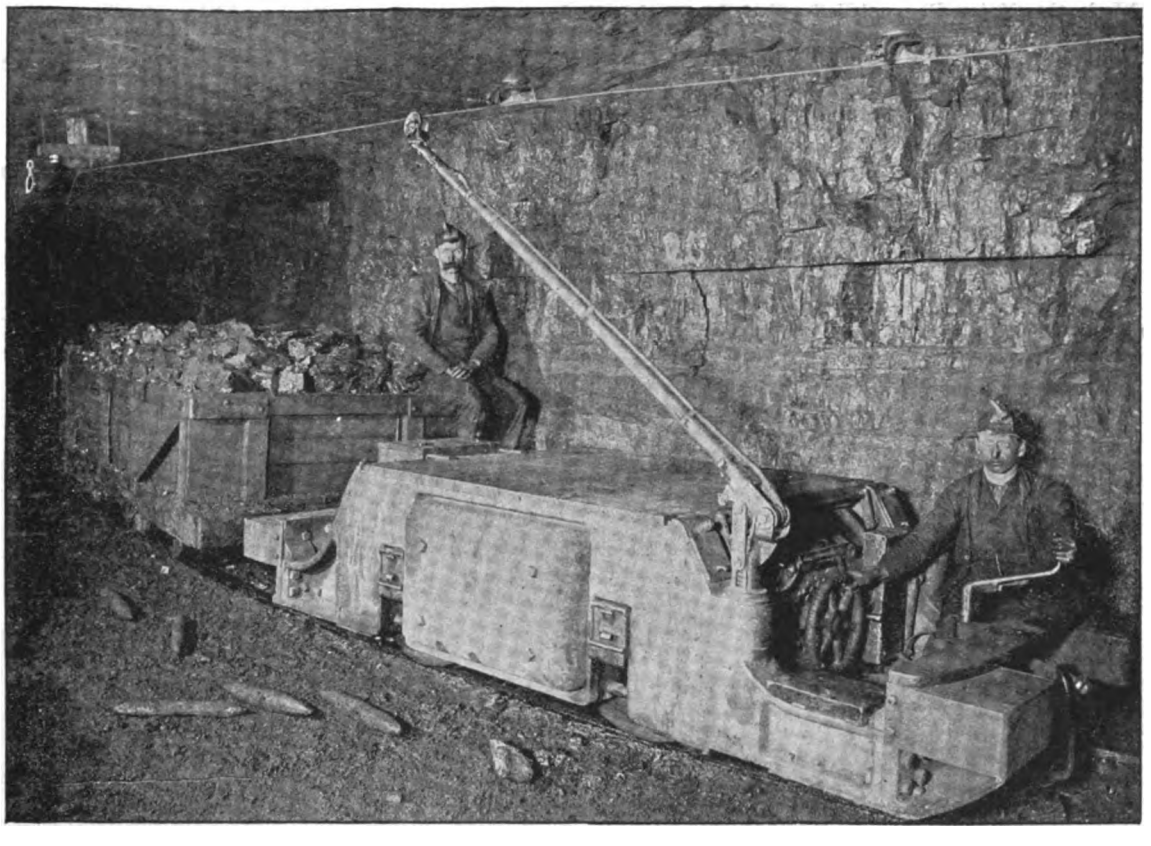
The Electrical Age.

VOL. XXII—No. 23 NEW YORK, DECEMBER 3, 1898 WHOLE NO. 603

ELECTRIC MINING.



Double-Action Pump for Falls from 150 ft. Head. 50 H. P. Motor. D., L. & W. R. R., Bellevue, Pa.



Mt. Lookout Mine, Wyoming. Pa.

ELECTRICITY IN MINING.

Within the last twenty years the mining trade has grown to such enormous proportions that it may be regarded as one of the foundations of wealth in the United States. The wheat crop is not more important than the output of our coal, iron, gold, silver and copper mines. In order to facilitate mining in all its phases engineers have acted upon every practical suggestion which seemed to lead to a reduction in the cost of obtaining either of the above-mentioned minerals. The great Anaconda mine of the West, with its huge electrolytic refinery, having a capacity of fifty tons of pure copper a day, is an example of the crystallization of a valuable idea.

In coal mining electric drills perform their work with dispatch and efficiency, and for pumping and in many cases for fusing mineral products, experience has taught us that of all flexible and most easily applied forces electricity stands foremost. The mineral resources of the United States and of its practically newly annexed territory, Cuba and the Phillipines, are such that the total output will be increased by a large percentage. In these

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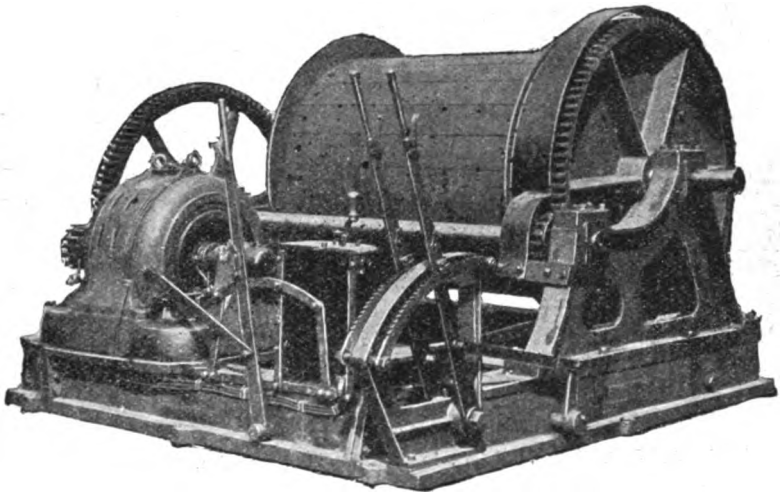
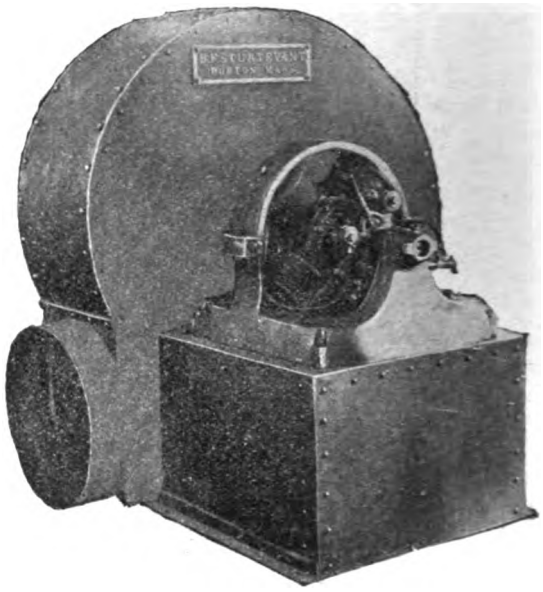
cases the old-fashioned and almost primeval methods of mining hitherto followed will give way, in the face of American enterprise, to the newer, better and more economical methods which the free use of electricity entails.

In the practice of mining, machinery is required for pumping, drilling, transporting, lifting, refining and melting the mineral products. Each of these departments of work can be, to a large extent, successfully carried out by the substitution of electricity for whatever power has been previously used. In mining, as in any other field of engineering, economy and quick work are the two factors of prime importance. By economy we would mean not a saving bought at a large expense, and by quick work not dispatch that involves the use of cumbersome or complicated machinery.

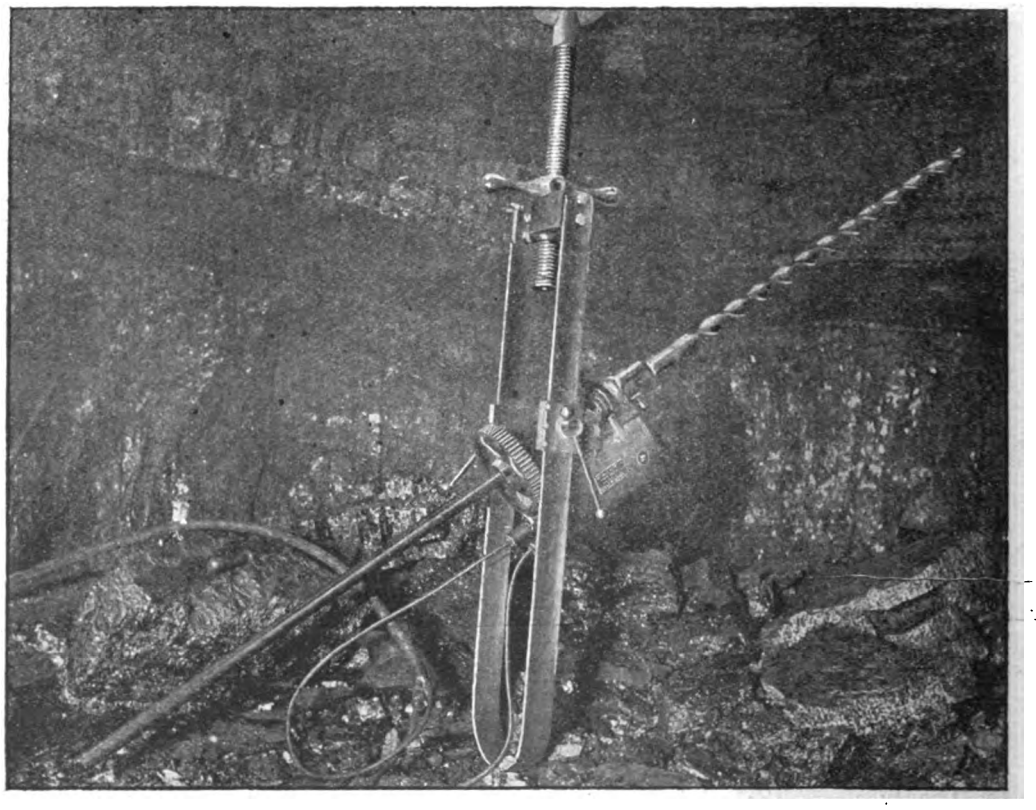
The electric hoists, electric pumps, drills, fans, coal cutters, locomotives, etc., that are used in mines operated by modern machinery, are extremely durable and, comparatively speaking, extremely efficient machines. The attention any electrical or mechanical device receives in a mine is the very least it could possibly receive under any circumstances. The general class of laborers entrusted with the care of working machinery in the mine itself are never above the average intelligence, consequently their patience and skill in repairing are of a rather limited character. To the owners of a mine the great question to be answered is, what do I save by using electrical machinery? and the answer to be given is this: that provided the power is cheap enough, being obtained from some distant transmission plant or generated on the premises, electric pumps, hoists, locomotives, and even drills, are cheaper to operate and far more convenient to handle. Then again, electricity in a mine and around the mine is practically a necessity. Electric lights, whether arcs or incandescents, are the only means by which its gloomy interior is illuminated sufficiently to remove the great danger



Hoist and Induction Motor, Pleasant Valley Coal Co., Pl. Val., Utah.



Blower with D. C. Motor.



Electric Coal Augur Drill.

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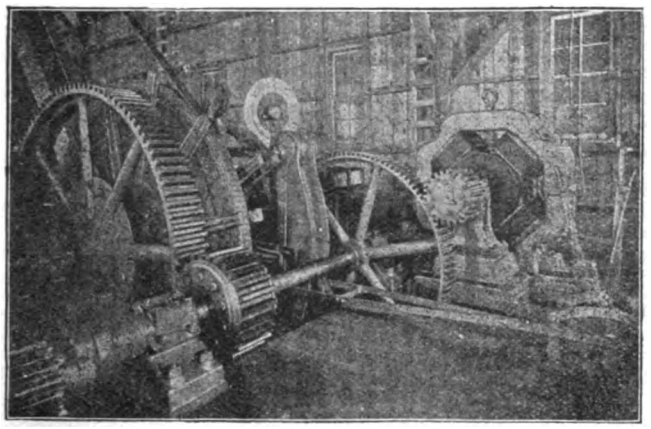
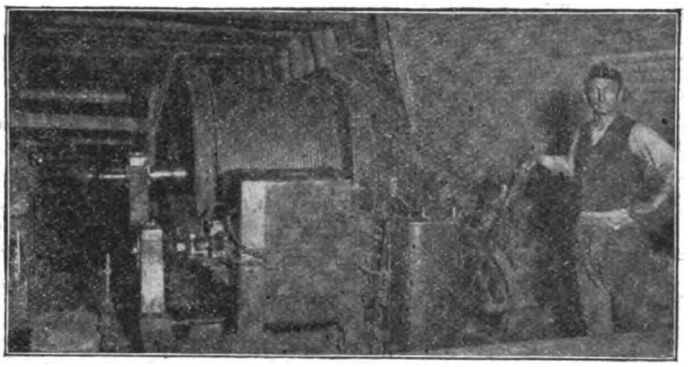
constantly present of fatal accidents to those more careless than discreet.

In reference to the transmission of power it may be said that the mining industry has been the incentive through which the engineering profession have turned their attention seriously to this class of work with an eye to its commercial importance. The frequency with which mining centres become busy towns in which the original occupation gives way to others of an agricultural or foreign industrial nature can be readily understood and believed by viewing the map of the western coast of the United States. It must not be forgotten, however, that the extreme flexibility of an electric system of power transmission would be useless if it were not for the great advantages offered by the ready adaptability of an electric current when generated in the polyphase form for the running of motors in direct connection with hoists, pumps, blowers and many other varied types of electrical machines. Consequently it becomes possible for mining operations to be carried on in an isolated spot, inaccessible as far as the transportation of fuel is concerned, but supported and entirely dependent upon a waterfall or power installation situated miles and miles away.

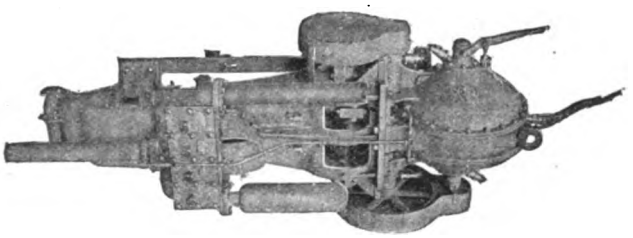


Double-Reel Hoist, 100 H. P. Motor, Free Silver Shaft, Aspen, Colo.

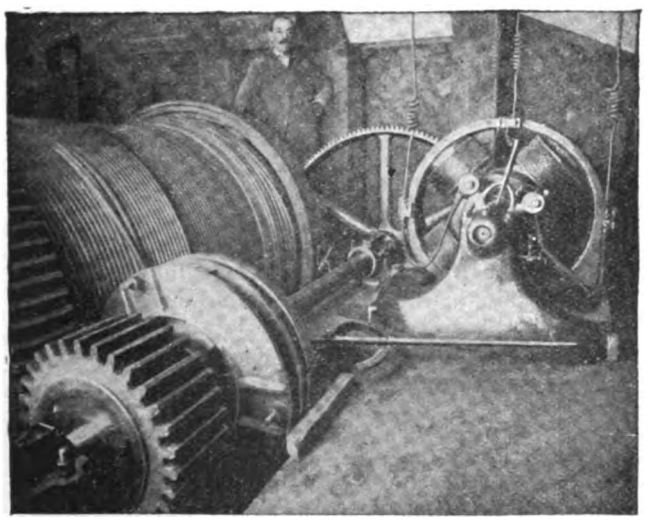


Electric Hoist with G. E. Motor, Lehigh Valley Coal Co.

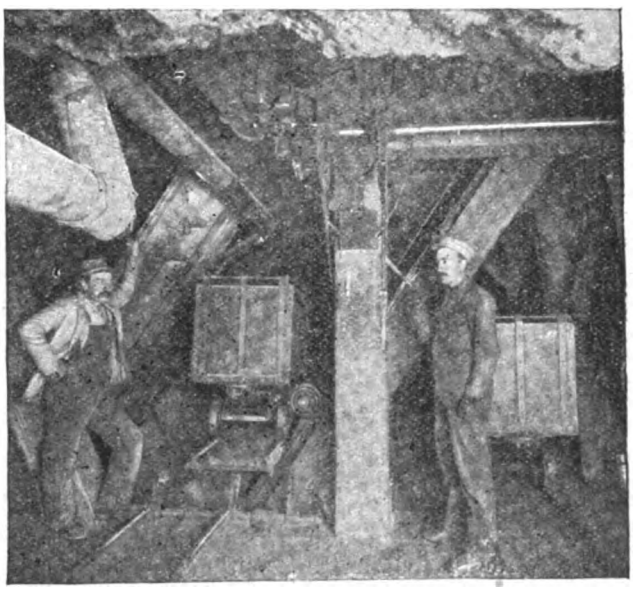
In tunnelling into the mountain sides in search of a vein the use of electrically-driven fans for preserving the hygienic conditions by driving a great blast of air forward without heating it makes the application of electricity in such a case indispensable as an important adjunct. Hence it is seen that for lighting, ventilating, hoisting, drilling and transporting, electricity has become the able and successful competitor of steam and compressed air through which dividends may increase, accidents be prevented and lives saved.



Sucking Pump, 20 H. P. Ind Motor.



Alta Argent Mine, Aspen, Colo., Hoist and Motor.



Alta Argent Mine, Aspen, Colo. Top of Incline. Motor in room above.

Savannah, Ga.—Edison Electric Illuminating Co. has purchased site for its proposed electric plant. An electric light and power plant, to cost $150,000, will be erected immediately.

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ELECTRIC LIGHTING.

THE NERNST LAMP.

The development of the incandescent lamp has reached a certain stage beyond which further improvement will involve a radical departure. To increase the efficiency of the electric lamp without decreasing its life or affecting its durability has been of late one of the greatest of modern problems.

The Nernst lamp, a description of which is published in "Science," has received considerable attention in the columns of a German paper. The "Frankfurter Zeitung" contained recently a very interesting account of Prof. Nernst's new electric lamp. As information on this subject has heretofore been so difficult to obtain, a brief abstract from this article may be of interest to readers. As has been previously announced, Prof. Nernst employs magnesium oxide for the illuminating material, which, at ordinary temperatures, is a non-conductor, but when heated to a sufficiently high degree (and herein lies Prof. Nenrst's discovery) becomes a perfect conductor and emits a brilliant white light. The preliminary heating of the magnesia, A, Prof. Nernst accomplishes by placing it in the focus of a reflector, C, as seen in Figure 1. On the inner side of the reflector is a spiral wire of platinum, D, which, when brought to incandescence by a current, produces heat sufficient to render the magnesia a conductor; a current is then passed directly through the oxide by the wire, B, and that in the spiral is shut off.

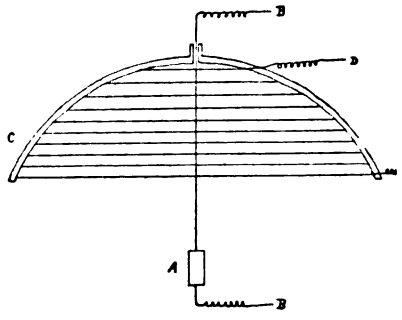
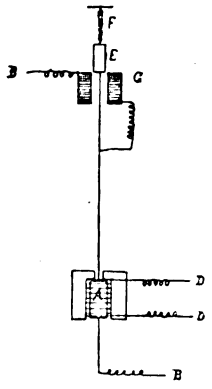


Fig. 1.



A complicated form of lamp is seen in Figure 2. Here the magnesia, A, is placed within a cylinder, C, which also encloses a platinum spiral, D. As soon as the incandescent spiral has heated the magnesia sufficiently a current passes through the oxide by the wire, B. Within this circuit is a coil, G, which, upon becoming magnetic, draws down the iron bar, E, thus lowering the now incandescent magnesia from within the cylinder. Upon breaking the circuit the coil loses its magnetism, and a spring, F, raises the iron bar and magnesia to their former position.

As advantages over the ordinary incandescent lamps, Prof. Nernst claims that the same amount of light can be furnished at one-thiad the cost, and, as the magnesia allows of being heated to a much higher degree than a carbon filament, a purer light is obtained. The successful employment of a cheaper substitute for the platinum is also announced, though the name is not made public. In operating, either an alternating or direct current is used.

(Signed) H. Monmouth Smith.

Hampden-Sidney, Va.

THE STORAGE BATTERY.

AN ELECTRIC ACCUMULATOR PLANT.

According to R. B. Ritter, in "L'Electricien," the electrical generating plant of Fribourg, which has replaced the original teledynamic installation, is driven by water-power obtained from the River Sarine, and supplies electrical energy on the three-wire direct-current system to the town of Fribourg, distant about 1,500 meters. Two turbines are used, driving four Thury dynamos, with a total capacity of 500 kilowatts; there are two distribution networks, one for motor supply at 700 volts across the outers, and one for lighting at 300 volts across the outers. In order to cope with any increase in the demand, two batteries of accumulators have been installed in the cellars of the Town Hall, where also the feeders and mains terminate. The cells are of the Theryc-Oblasser type, each plate being inclosed in a sheath of perforated celluloid, which supports the active material in place. There are 83 elements in each battery, having a capacity of 2,600 ampere hours at a discharge rate of 130 amperes, or 1,400 ampere-hours at 400 amperes, with a fall of pressure of 10 per cent. Each element consists of 50 plates, 250 mm. by 200 mm., contained in two glass cells, and weighing 138 kg. in all. As the maximum pressure obtainable from the lighting generators is 175 volts, a number of the cells are cut out of circuit when the main batteries are charged, and these cells are separately charged by means of a 50-H. P. Lundal motor run off the 300-volts circuit, which drives two charging dynamos. The latter are protected against reverse currents by automatic switches.

The discharge is regulated by the Trumpy system of automatic gear; relays connected by pilot wires with the distributing network actuate regulating switches, which cut out or add cells as required to keep the pressure constant.—Ex.

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The Electrical Age.

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ELECTROSTATIC GENERATORS.

The use of static electricity has more than once been attempted for industrial purposes with little or no success. For automatic gas lighting, no doubt seems to arise as to its efficiency, but in broader fields of work its application fails absolutely. Professor Trowbridge has shown by sketch a method of utilizing Leyden-jar or condenser discharges for eletric lighting. These charges are originally produced by an electrostatic generator driven in the ordinary manner by motive power. The idea is to use the oscillations of the leyden jars through a finely-wound primary. Around this is wrapped a secondary of heavier wire connected to a bank of lamps. The question arising in such a case would be as follows: What is the output of the electrostatic generator in comparison with the horse-power applied? Were it merely as a matter of experiment the information would be received with great gratification by many scientists. The high efficiency of the electro-magnetic generator, the dynamo, is generally accepted as being between 90 and 100 per cent. in large-sized machines. What it would be with a machine more purely a dynamo, in the sense of causing no internal transformations of a magnetic nature, is difficult to conclude *a priori*, but an inference might be made of a most favorable nature on account of the extreme simplicity of electrostatic machinery.

Invention has followed such steps ever since man has been occupied with that fascinating art. The greatest inventions are the simplest, as they represent, as a rule, the first crystallization of basic principles. The high potentials now utilized on transmission of power lines will, if they continue to increase, compare very favorably with the static discharges of large Leyden jars. One advantage the use of Leyden jars involves is the charge and recovery, without chemical change, of all the energy stored away. In addition it may be said that condensers are now largely used for a variety of purposes. Their technical features of construction are thoroughly understood, and in comparison with earlier practice are made infinitely superior and much larger.

The close of this century has shown a great familiarity with high pressures by electrical engineers. This is, of course, due to the enormous number of transmission plants that have and are being erected. It may be that the science will bear fruit sufficiently to turn some one's attention to static generators as possible sources of commercial electrical energy.

ROTATING MAGNETIC FIELDS.

The experiments of Arago were of such supreme importance to the commercial world that there is a possibility, had they never been made, progress would have been retarded for at least a score of years and investments exceeding twenty millions of dollars never have been made. From Arago's spinning disk, first set into rotation in 1825, there came into being in rapid succession devices to which we owe the present form of the rotary magnetic field motor. Faraday's disk machine, Sturgeon's researches, the efforts of Le Roux, Willoughby, Smith, Guthrie and Boys, etc., quickly established the true meaning of rotating magnetic field and eddy currents in copper disks moved in or exposed to a varying magnetic field.

Mecl anical rotation was actually produced spontaneously by De Touvielle and Lontin, whose apparatus did not differ materially from such of the simpler forms of mechanism in use at the present day.

Walter Bailey has been credited with the invention of the first polyphase motor, which he exhibited in 1879, but investigation shows claims which seem to be made in all the principal cities of the world by various scientific men.

The first value accorded an idea is not always a proof either of its practicability or future importance. It requires persistent and patient effort to clothe it with the form best adapted to the end in view. Tesla's work, dating from the years '87 to '91, gave an impetus to polyphase current work which must be recognized as having been vitally important, commercially and electrically. It affected the future of transmission work to an extent that admits of no limitation and brought into existence a system and class of machinery radically different from anything that had hitherto been suggested.

The rotating magnetic field produced by polyphase currents in its many industrial applications covers a vast field no less important than that created by Watt, Fulton and Stephenson.

Monroe, La.—The Mayor may be addressed for information concerning proposed construction of electric-light plant, for which bonds will be issued.

Kissimmee, Fla.—J. M. Bailey is interested in the proposed construction of electric-light plant.

Fredericksburg, Va.—A new electric-light plant is to be established.

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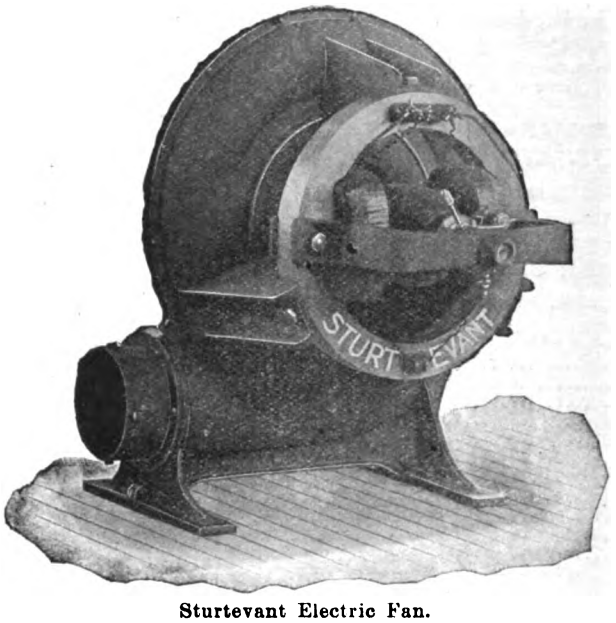
ELECTRIC VENTILATION.

STURTEVANT ELECTRIC FANS.

The ventilation of buildings has developed into a science since the introduction of electric motors and the sale of electricity to consumers. The hygienic benefit of fresh air need not be discussed, as it is universally admitted that this apparent luxury will soon become a necessity. In fact, in many establishments blowers are indispensable articles of use, without which business would be interfered with and losses sustained of so serious a nature as to make an investment in electric blowers a trifle in comparison. The two electric fans described in this article are manufactured by the B. F. Sturtevant Company, Boston, Mass., with offices at 131 Liberty street, New York.

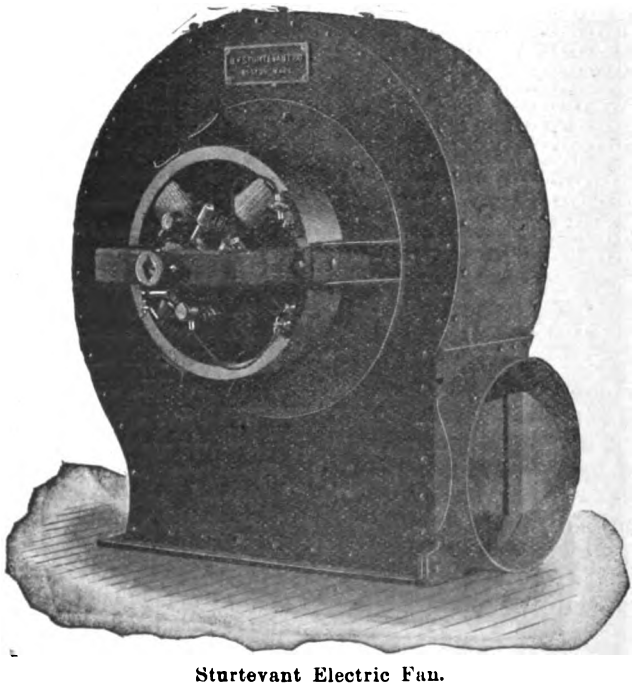


Sturtevant Electric Fan.

The fan illustrated in Fig. 1 is of the steel pressure type, designed for producing pressures from four oz. per sq. in. and upwards, and requires operation at high rotative speed. The motor is supported and centred by three projecting lugs turned to fit the motor ring. This ring is of wrought iron, and the motor, as will be noted, is of the bipolar type, with two bearings carried in yokes and provided with ring oilers.

The commutator segments are of drawn or rolled copper, and the armature is of the toothed drum type, with modified Siemens winding. The brush holders have the reaction feature and are self-adjusting, while the brushes themselves are of fibre graphite, which requires a minimum of attendance.

In Fig. 2 is illustrated a steel plate fan designed for ventilation and operating at pressures of one oz. per sq. in. and under. The rotative speed is comparatively low. A cast iron plate with projecting lugs holds the motor and is secured to the fan side. The ring in this type is of wrought iron, the motor is multipolar, and the bearings are two in number, with ring oilers supported in yokes.



Sturtevant Electric Fan.

The motor is a toothed ring mounted on a brass spider, to the front end of which is secured the commutator. This commutator, which is of pure rolled or drawn copper, is of exceptionally large diameter, thus giving a large radiating and contact surface. The brushes and holders are of the reaction and self-adjusting type, and thus make it possible to secure perfect operation. The entire arrangement is such as to cause the motor to project as little as possible from the side of the fan casing, thereby making it compact and reducing the floor space.

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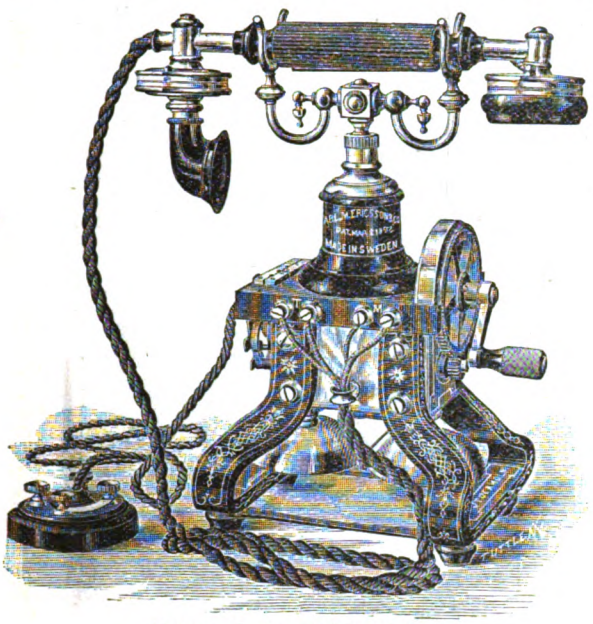
TELEPHONIC.

FAMOUS SWEDISH TELEPHONES.

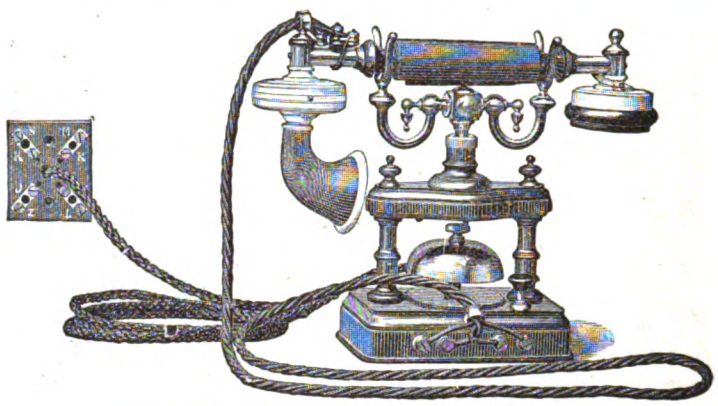
Telephone construction abroad has reached a high stage of perfection. The receiver of Alexander Graham Bell and the original transmitter derived from the principle of Hughes' microphone have undergone many modi-



Ericsson's Swedish Desk Set.

fications. The transmitter has been improved upon by the inventor Ericcson until the audibility of sound conveyed through its means is so pronounced and the syllabification is so distinct that little remains to be perfected in this respect. The inventor referred to is Mr. A. B. L. M. Ericcson, of Swedish fame. The receivers and transmitters, telephone system complete, have made his name a byword among telephone people through their great success on the market.

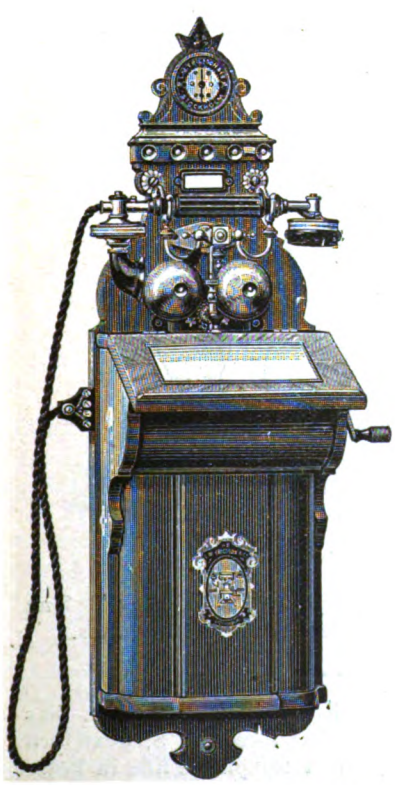
The first prizes were awarded to the Ericcson Telephone Company at Paris, in 1881; Madrid, 1883; Vienna, 1884; Stockholm, 1886; Copenhagen, 1888, and Chicago 1893. The telephone outfits and telephone accessories illustrated are sold by the Ericcson Telephone Company of 20 Warren street, New York city. They are the genuine Ericcson goods, differing slightly from the imported article in the style of wood-work, which is made



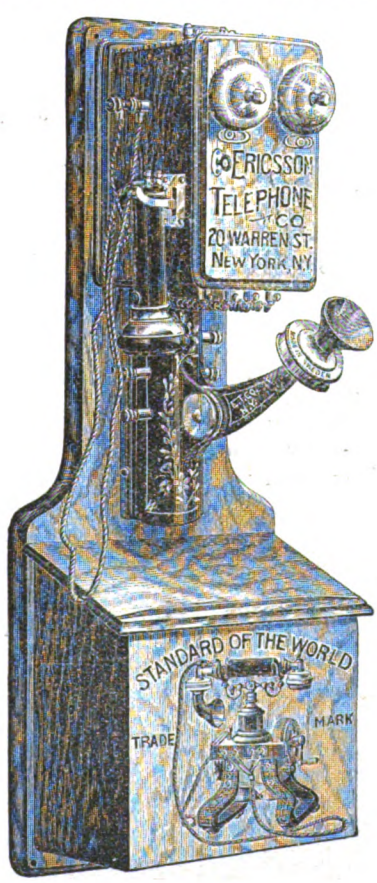
Ericsson's Swedish Battery Call. With Bell.

thoroughly American in appearance. But the telephones themselves, the working parts, are imported direct from Sweden.

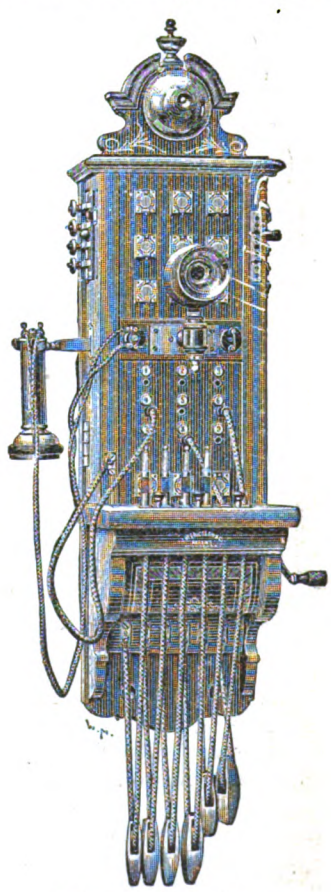
One of the best products of Ericcson's persistent labor is the Swedish coal-grain microphone. This transmitter is absolutely perfect and has acquired so great a reputation in this country and abroad that it is regarded as the *ne plus ultra* of 'phones. It can, of course, be used in connection with any outfit, with perfect ease. In this



Ericsson's Samson Set for Long Distance Work.



Standard Long Distance Wall Set, with Adjustable arm, fitted with Ericsson's Swedish Coal Grain Microphone and Double Pole Receiver.



Ericsson's Switchboard.

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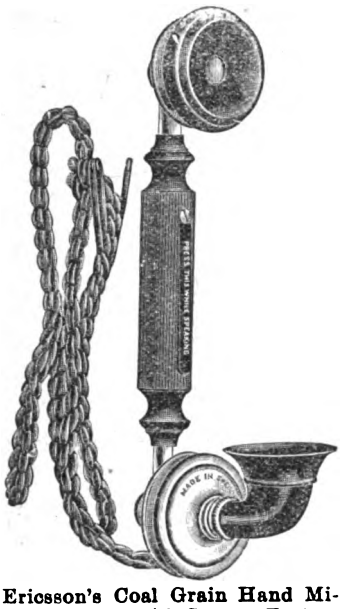
instrument the construction is such that bad contacts and packing will not occur and adjustment is not necessary. In combination with the double-pole receiver the quality of sound is so excellent that there is little left to be desired.

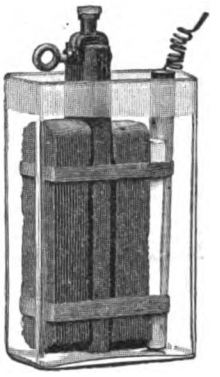
The Ericcson Telephone Company manufacture the famous coal-grain hand micro-telephone with contact fastenings. This can be held to the face suiting the ear and mouth at the same time. The desk set, consisting of stand, transmitter and receiver, has in addition a twenty-five thousand ohm magneto. This outfit is remarkable above all for its clearness in speech both in sending and receiving. The battery call and bell telephonic outfit is similar in construction, with the exception of the magneto.

This company sells the transformer used in circuit work for transforming the grounded into metallic or metallic into grounded circuits. The Ericcson Swedish long-distance exchange sets are beautifully designed. They operate to perfection, require little or no attention and present from an æsthetic point of view an exceedingly handsome appearance. The combination sets are made in a variety of styles, with and without battery box. Their number 622 switchboard outfit, built in all sizes, both trunk line and multiple for grounded or metallic circuits.

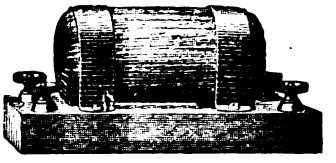
In conclusion, it may be stated that they have gotten up a portable testing set with battery included. It is called the fault-finding lineman's set. It possesses neither transmitter nor receiver. It represents the acme of convenience and the most desirable quality of portability. The genuine Ericcson telephones are stamped "made in Sweden," also with the signature as follows: "A. B. L. M. Ericcson & Company. Patented Oct. 29th, 1895." The last date is to be found in all coal-grain microphones.



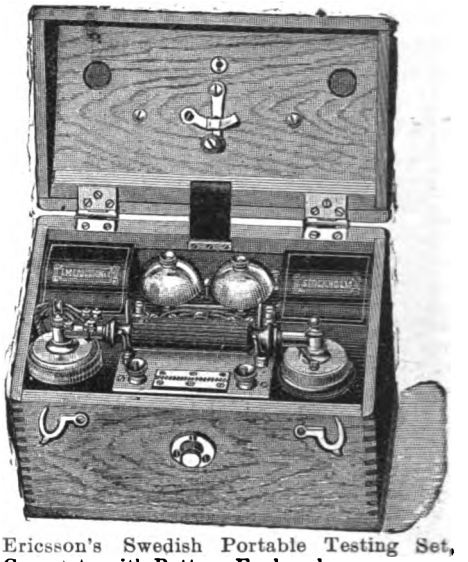
Ericsson's Coal Grain Hand Microtelephone with Contact Fastenings.



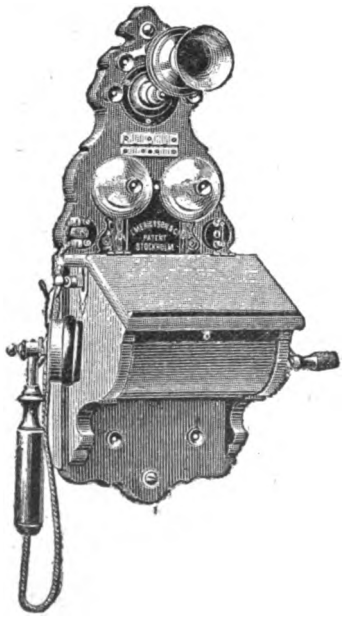
Ericsson's Swedish Samson Battery.



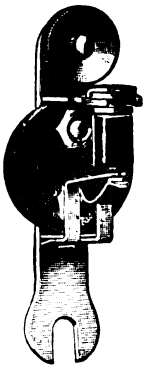
Ericsson's Swedish Transformer.



Ericsson's Swedish Portable Testing Set, Complete with Battery Enclosed.



Ericsson Wall Set.



Ericsson's Swedish lightning protector for high and low tension current.

Ericsson Desk Telephone.

Potsdam, N. Y.—Rocket River Telephone Co. has been incorporated by J. A. Crawford, M. S. Crawford and Fred C. Ward; to operate a telephone line in Potsdam. Capital stock, $6,000.

Somerville, Tenn.—W. D. Scruggs may be addressed concerning erection of proposed electric light plant.

Ewan, N. J.—City Clerk may be addressed concerning contemplated electric light plant.

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STRAY CURRENTS.

ELECTRIC INSTALLATIONS ON THE PACIFIC SLOPE. During the past eight years fifty-two distinct companies in the Rocky Mountain district alone have installed electric power machinery for mining and ore reducing purposes. The plant comprises 62 generators, aggregating 7,988 kilowatts, and 135 motors, aggregating 4,816 horse power, operating every variety of mining and milling machinery. —Ex.

COMMERCIAL ELECTROLYSIS OF WATER. The chief difficulty in the electrolytic preparation of hydrogen and oxygen lies in the complete separation of the gases. In Garuttl's process he uses a metallic diaphragm inserted in the cell, but not reaching the bottom, so as to allow sufficient space for the passage of the liquor from one electrode to the other. A plant of thirty-two cells, yielding daily 30 cu. m. of oxygen and 60 of hydrogen, has been working for six months, and the gases are sufficiently pure for commercial purposes, the oxygen containing about 1.5 per cent. of hydrogen, and the hydrogen only a trace of oxygen. This process is operating very satisfactorily and economically in Italy, Switzerland and Belgium, yielding very pure oxygen at a cost of less than half a cent a cubic foot, leaving a large margin of profit. The electrolyzer consists of steel plate cells, the bottoms of the diaphragms being provided with small apertures, allowing the electrolyte to pass through, but not the gas bubbles, thus preventing the gases from mixing.—Ex.

TROLLEY TRAVEL IN BOSTON. Boston travel on the suburban steam lines in the last four years is estimated by the State Railroad Board to have decreased about 10 per cent., while the corresponding trolley travel has increased 25 per cent. It runs this way all through New England.—Ex.

VESTADIUM. Vestadium is a recently discovered white metallic alloy, of a beautiful appearance and great strength. It seems to meet with as quick and general an acceptance as was the case with aluminum. It is said to be firmer and much more practical than any other known metal of equal specific gravity. It is claimed to be composed chiefly of an aluminum alloy, and only weighs one-third as much as aluminum of the same size. Furthermore, it is said not to rust, to withstand sulphuric acid, to take a fine polish, never to tarnish, and once polished, never to require cleaning.—Ex.

FIRES IN SHOP WINDOWS. In view of the numerous fires that have recently taken place in shop windows in Germany, the German police have issued a notice containing the following recommendations, says "The Electrician:" All glow lamps used in shop windows should be provided with globes, shades or wire guards, or so arranged that they cannot come into direct contact with inflammable material. If the lamps are surrounded with silk or other fabrics, the covering must not envelope the lamp completely, so that the air can circulate between the lamp and the covering. Arc lamps should be provided with ash trays of metal instead of the glass ones usually employed. Conducting wires in the windows should be well insulated.—Ex.

MAGNETIC SURVEY OF THE GLOBE. A conference of scientists, held at Bristol, Eng., in connection with the British Association for the Advancement of Science, has just concluded its labors. The question for deliberation before this body, wherein Charles A. Schott, of the coast survey, represented the United States, concerned the preparation of a plan for a systematic survey of the entire globe, and the deliberation of the conference resulted in a general recommendation for that purpose. The principal work of the conference centred in the wider questions involving magnetic observations; their at present unsatisfactory distribution over the globe, and their inadequacy as regards numbers. The United States is in a position to take a most important step in the advancement of our knowledge of terrestrial magnetism by establishing and maintaining a well-equipped magnetic observatory on one of the Hawaiian Islands. Their position is unique, being central to a vast unexplored, or, rather, magnetically unknown, region, and well adapted for the special study of the modifications which the diurnal and secular variations of the magnetic needle are supposed to undergo in consequence of a surrounding ocean as contrasted with a continental surface.—Ex.

OSMIUM FILAMENTS FOR ELECTRIC LAMPS. Two months ago we drew attention to the new discoveries with which Auer von Welsbach and also Nernst are credited. The subject has exercised the press a great deal, and may continue to do so, since the new Welsbach patents threaten to establish another monopoly. Welsbach's claims are of the broadest kind. The metals proposed are osmium alone, and osmium combined with platinum, iridium, ruthenium, etc., coated with alloys or with oxides, etc. The filaments are manufactured by depositing osmium from its volatile tetroxide on a very thin platinum wire, which is afterwards evaporated by passing a strong electric current through it, or by mechanically applying layers of osmium and cements to a wire or vegetable fibre by electrolytic depositions, etc. The osmium, as metal or oxide, may also be employed in an emulsion with collodion, which is spun and denitrated like artificial silk. In addition to the oxides, the osmium sulphide is recommended. The thin coating of thoria, which is likewise proposed, is to be applied in several layers, and each coat is to be calcined.—Ex.

PRODUCTS OF THE ELECTRIC FURNACE.

MANUFACTURE OF CALCIUM CARBIDE.*

There are no official statistics as to the annual output of calcium carbide in France, and it is necessary to estimate the amount furnished yearly by the different manufacturers. The American Consul at Havre says that these estimates vary from 1,000 to 5,000 tons a year from each factory. There are at present ten factories engaged in the manufacture of carbide of calcium in France. Two are at La Bathie, and one each at Séchilienne, Froges, Chapareillan, Lancy, Notre Dame de Briançon, St. Beron, Bellegarde, and Crampagna. Four factories are under construction. They will be situated at St. Etienne de Maurienne, Epierre, Serres, and Chute de Giffre. They will be able to produce, when running at their full capacity, from 2,500 to 3,000 tons per year. The wholesale price of carbide of calcium in France is from 350 to 400 f. per ton, exclusive of cost of packing. The cost of packing is 4.50 f. per iron drum containing 110 lb.; 6 f. per drum of 220 lb. The carbide of calcium manufactured in France is guaranteed to give 300 cubic litres of gas per kilo. The output is constantly increasing, and the supply is fully equal to the demand. The retail price of the article is from 55 f. to 60 f. per 100 kilos., not including packing. There are two villages in France completely lighted by acetylene, by the Société Franco-Espagnole du Gaz Acétylène, of 81, Rue St. Lazare, Paris. They are Alzonne, in the department of Aude, a town of 1,506 inhabitants, and Saurat-par-Tarascon, in the department of Ariege, a place of 3,024 inhabitants.

* Trade Journal's Review.

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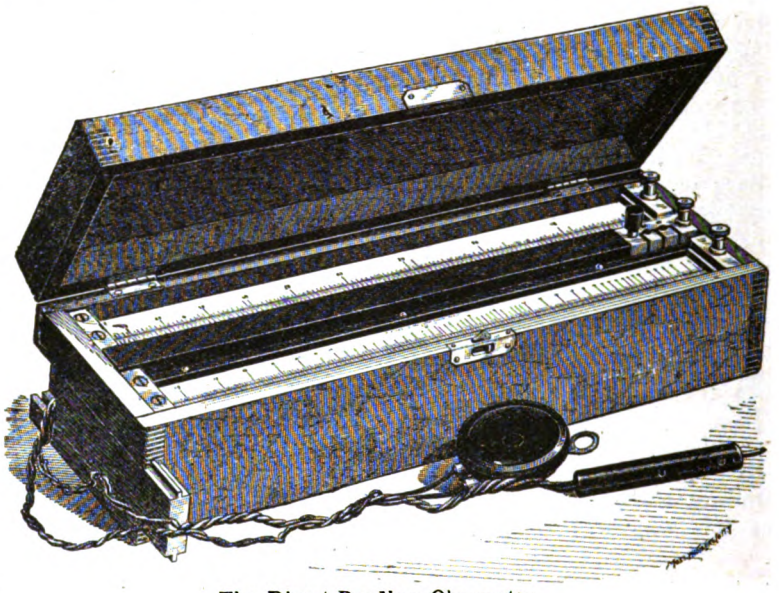
ELECTRICAL MEASUREMENTS.

THE DIRECT-READING OHMMETER.

A most interesting and practical instrument is the direct-reading ohmmeter, by means of which resistances may be accurately and readily measured. There are many occasions where a ready means of measuring resistance would be greatly appreciated by electrical men; for instance, those in care of an electric light plant and for station and street railway use, as well as laboratory purposes. From such as these the ohmmeter will receive a hearty welcome.

The instrument is used as follows: A telephone attached to it is placed over the ear, the battery key depressed, and the light wire, which is stretched over the scale, is touched in different points by the stylus till a point is found where there is no sound in the receiver. When the resistance has been found the receiver becomes silent, and the reading indicated by the stylus gives the number of ohms. This instrument is supplied with a battery which will last six months, if frequently used; longer otherwise. Its great convenience will and is making it exceedingly popular.



The Direct-Reading Ohmmeter.

The ohmmeter is manufactured and sold by the American Electric Specialty Co., 123 Liberty street, New York.

CONSTITUTION AND RESISTANCE OF MERCURY.

At the recent congress held by La Société Allemande d'Electrochimie at Leipsic, a paper was communicated by M. Liebenow with regard to the constitution of mercury. From his experiments it appears that the electrical resistance of the alloys depends principally upon the molecular grouping, i. e., upon the number of atoms forming the molecule of the solid substance. In the case of solid mercury the molecular grouping is extremely complex, but in the gaseous condition it is probably monoatomic. It is remarkable that, whereas for most pure metals, including solid mercury, the temperature coefficient for resistance is in the neighborhood of 0.004 per 1° C., whilst for liquid mercury the coefficient is only 0.001. Liquid mercury appears to be a mixture of monoatomic molecules, and the more complex groupings characteristic of the solid condition.

Royal Oak, Mich.—City Clerk may be addressed concerning establishment of electric light plant.

INSULATION.

OXYLINE.

That great hopes seem to be based upon oxyline (the recently discovered substitute for india-rubber) is evident from the report which the French Consul, at Dusseldorf, sends to the "Moniteur Officiel du Commerce." He says that this new material, which is obtained by the oxidation of linseed oil, mixed with an agglutinant substance such as crushed jute or other almost valueless wastes of textile materials, is now being made in factories established at Piesteritz, near Wittenburg, on the Elbe. These factories, "Oxyline Werke," belong to a joint stock company, founded by the Leipsic Bank, which has bought the patent for Germany and Austria-Hungary. If this new artificial material can be shown to be suitable for the numerous purposes indicated, the consul thinks it certain that the price of caoutchouc cannot be maintained at its present level. A fall of any importance in the near future cannot, however, be expected, as time will not have allowed of the extended production of oxyline. It remains to be ascertained if, and to what extent, it can replace caoutchoue, and what results it will give as to durability. It is proposed to use oxyline for machinery packing, cable coverings, and insulating plates in the electrical industry, as well as for floorcloths in place of linoleums.—Ex.

ELECTRIC LIGHT AND POWER.

POWER REQUIRED FOR MACHINE TOOLS.

It is stated that at the Baldwin Locomotive Works there are 215 motors, the aggregate horse power of which is 700, for driving cranes and machine tools. To keep these in motion and repair requires the services of only two men, wi h a third of the time of another man; the annual cost of labor and material being about £500. Smaller machines are grouped, and large machines have each separate motors allotted to them. A 70-inch wheel lathe requires 1.5 h. p. to run it empty, and 6.2 h. p. to run it under the full load of two cuts ½-inch deep on a 56-inch wheel. A frame slotter, with 18-inch stroke, taking a heavy cut, absorbs 10.3 h. p.; when light, it requires only 2.3 h. p. A large double frame planer, with two ½-inch cuts, absorbs 11 and 21.6 h. p. empty and loaded. A drill requiring 2.85 h. p. when drilling a 2¼-inch hole, uses only 0.97 h. p. when running light. To bend steel plate 11-16 inch thick by 10 ft. 6 inches long takes 19.8 h. p., while the empty machine requires 3.5 horse power.—Ex.

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AMONG THE SOCIETIES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The 129th meeting of the Institute was held at 12 West 31st street, Wednesday evening, November 23d, President Kennelly in the chair. The paper of the evening on "The Design of Transformers," by F. W. Carter, of London, England, was read by Prof. W. S. Franklin, of Lehigh University, in the absence of the author. It was discussed by Messrs. Franklin, W. B. Jackson, Wolcott, Henshaw, Torchio and others.

At the meeting of the Executive Committee in the afternoon the following Associate Members were elected:

Cleveland Abbe, residence 2017 I street, N. W., Washington, D. C.

John Cassidy, Honolulu, Hawaiian Islands, U. S. A.

James Francis Cosgrove, 631 Madison avenue, Scranton, Pa.

Donald Hume Fry, Blue Lakes City, Col.

James Hamilton, 54 State street, Boston, Mass.

Bernhard Hoffman, 15 Dey street, New York City.

Harry D. James, 100 Buena Vista avenue, Yonkers, N. Y.

S. L. G. Knox, Montclair, N. J.

Howard Wallace Leitch, 373 Madison street, Brooklyn, N. Y.

R. W. Lohmann, 1387 Madison street, Oakland, Cal.

C. Stowe Reno, 62 Baymillen street, Cincinnati, Ohio.

R. H. Sperling, Victoria, B. C.

James Wilkinson, 862 South 19th street, Birmingham, Ala.

A. Wilford Zahn, Manhattan Building, St. Paul, Minn.

The following Associate Members were transferred to Full Membership:

Franklin Robert Anson, secretary and manager, Salem Light & Traction Co., Salem, Oregon.

Sidney Hand Browne, consulting electrical engineer, Baltimore, Md.

A. E. Brooke-Ridley, agent and electrical engineer, Siemens & Halske Electric Co., San Francisco.

The Committee on Co-operative Research, having completed the first stage of its work, has sent various collegiate electrical engineering departments an explanatory circular submitting twenty-seven subjects for investigation.

TIPS ON TRADE JOURNALS.

A PARABLE.

And it came to pass that after he had advertised his goods there came unto him great multitudes from all the region round about and did buy of him. And when his competitors saw it they marvelled among themselves, saying: "How be it that this man is busy, while we loaf about our doors?" And he spake unto them, saying: "Verily, verily, I say unto you, in this fast age of push and rustle, it is easier for a camel to enter the eye of a needle than for a business man to flourish without advertising."—"Printers' Ink."

Business News.

SPECIAL EXPORT COLUMN.

TOTAL ELECTRICAL EXPORTS FOR WEEK ENDING NOV. 29, 1898, $42,423.00.

New York, N. Y. Nov. 29, 1898. The following exports of electrical material are from the port of New York for the week ending this date:

Brazil—653 packages electrical material, $7,002.

British East Indies—147 packages electrical material, $4,456.

Bremen—15 cases electrical material, $3,000.

British Possessions in Africa—47 cases electrical material, $1,805.

Chili—9 cases electrical material, $403.

China—28 cases electrical material, $1,417.

Hong Kong—12 cases electrical material, $860; 14 cases electrical material, $108.

Hamburg—102 cases electrical material, $11,006.

Liverpool—1 case electrical material, $50; 28 cases electrical machinery, $585.

London—128 cases electrical material, $8,900.

Southampton—2 cases electrical machinery, $104.

U. S. of Columbia—3 cases electrical machinery, $1,650.

Venezuela—357 cases electrical material, $1,127.

TELEPHONE CALLS.

Memphis, Tenn.—The Cumberland Telephone & Telegraph Co. will build a structure for offices and exchange headquarters.

Christianburg, Va.—Aaron Graham proposes the construction of a telephone line to Roanoke.

Snow Hill, Md.—The Worcester County Telephone Co. is being organized by Dr. Geo. W. Bishop, Clayton J. Purnell, John F. Moore, Thos. M. Purnell, W. S. Powell and others; to construct a telephone system.

Vicksburg, Miss.—The Cumberland Telephone & Telegraph Co. will extend its telephone system, increase exchanges from 600 to 1,000 and make other improvements.

Paducah, Ky.—Henry Biederman will construct immediately telephone system, for which he obtained franchise.

Spencer, Iowa.—The Citizens' Telephone Co. has been incorporated, with a capital stock of $10,000.

Albany, N. Y.—The New Rochelle & Westchester Telephone Co. has been incorporated, with a capital stock of $150,000. Its directors are G. W. Sutton and Joseph Claudet, of New Rochelle; Frederick R. Kellogg and Horace A. Connor, of Brooklyn; Heinrich Meyer, of New York, and John H. Scofield and David G. Whiting, of Grandview. The company proposes to operate telephone systems in New Rochelle and vicinity, and to extend its lines to New York City, Boston, Buffalo nnd other intermediary places.

POSSIBLE INSTALLATIONS.

Richmond, Ky.—The Mayor may be addressed for information concerning electric light plant, for which franchise has been asked.

Clarence, Mo.—H. J. Williams, Mayor, may be addressed concerning establishment of a $5,000 electric light plant of 1,000 lights capacity.

Fredericksburg, Va.—City Clerk may give information concerning proposed erection of an electric light plant.

Gainesville, Ga.—James P. Edwards, of Augusta, Ga., contemplates the erection of an electric light plant in Gainesville.

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NEW INCORPORATIONS.

Jersey City, N. J.—Cooke's Electric Match Co. has been incorporated by George W. Sandford, Emma M. Cooke and Edward Sandford; to manufacture lighting devices. Capital stock, $50,000.

Red Lake, Minn.—The Red Lake Electric Light Co. has been incorporated by Marcus Johnson, Emma F. Marshall and Luman C. Stone. Capital stock, $8,000.

New York City.—The incorporation of the Otis Elevator Company has been announced. This corporation is a combination of the Otis, Sprague and various smaller elevator interests, and is capitalized at $11,000,000.

Macon, Mo.—The Trans-Mississippi Electric Light & Power Co. has been incorporated by Col. F. W. Blees, J. F. Schaefer and Charles E. Roel; for the purpose of establishing and managing electric light and power stations. Capital stock, $30,000.

STREET RAILWAY NEWS.

Flint, Mich.—Steps are being taken to build an electric line from Flint to Long Lake, to connect with the Corunna-Owosso road.

BUSINESS CHANCES.

Pittsburg, Pa.—Westinghouse Electric & Manufacturing Co., with a capital stock of $13,400,846, has been licensed for business in Illinois, with $29,000 capital.

FLASHES.

Oconto, Wis.—The Oconto Electric Light Co.'s plant destroyed by fire at a loss of $60,000; insured for only $18,000.

NEW YORK ITEMS.

Electrical supply dealers wishing to enlarge their stock will do well to write to the Standard Incandescent Light Co., 143 Centre street, for circulars.

O. Lindberg, 570 Fulton street, Brooklyn, desires to receive circulars and catalogues from manufacturers of electrical novelties and specialties. Mr. Lindberg is an electrical engineer with a large clientage and has a large store excellently located for the sale of electrical goods of all descriptions.

Mr. James H. Mason, the well known inventor and electrician, has opened up offices in the World Building, 59–63 Park Row. Mr. Mason is prepared to represent manufacturers of all kinds of electrical apparatus, having had a long and varied experience in this line of work.

Among the dealers in electrical supplies there are few who stand as high as Mr. J. Jones Jr., of the firm of J. Jones & Son, 64 Cortlandt street, in the estimation of buyers. There is no dealer more conscientious or anxious to cater to the demands of electrical buyers than Mr. Jones, and much praise is due him for his many good qualities. During the past few months Mr. Jones has been working under a great strain, due to the absence of his trusted manager, Mr. E. A. Lowe, and has spent many a day and night at his warehouses and factory, personally supervising orders and seeing that they were carefully carried out in every detail.

Mr. Norman H. Schneider, who recently severed his connection with the export department of the Western Electric Co., of this city, is now in Havana, Cuba, where he has opened up a wholesale and retail store at O'Reilly 1, for the Krajewski-Pesant Company. This company has secured the sole Cuban agencies for a number of American firms and also for the General Electric Company, of London, England, and is prepared to handle all kinds of machinery, electrical and other, tools, supplies, etc. Mr. Schneider will be pleased to hear from his old friends, and reports that his company is overhauling and restoring a number of plants in the province of Havana. Mr. Schneider, as will be known by many of our readers, is the author of "Norrie's Induction Coils."

WESTON STANDARD

PORTABLE DIRECT READING

VOLTMETERS AND WATTMETERS

For Alternating and Direct Current Circuits.

The only standard portable instrument of the type deserving this name.

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75c. "VULCAN" STYLOGRAPHIC PEN 75c.

"INDEPENDENT" FOUNTAIN PEN

PRICE, WITH ENGRAVED HOLDER, $2.00. SAME WITH GOLD BANDS, $2.50.

FOUNTAIN PENS LICENSED UNDER PATENTS 260,134 AND 311,664.

Send for our New Catalogue and Discounts. AGENTS WANTED.

J. K. ULLRICH & CO., 27 Thames St., New York.

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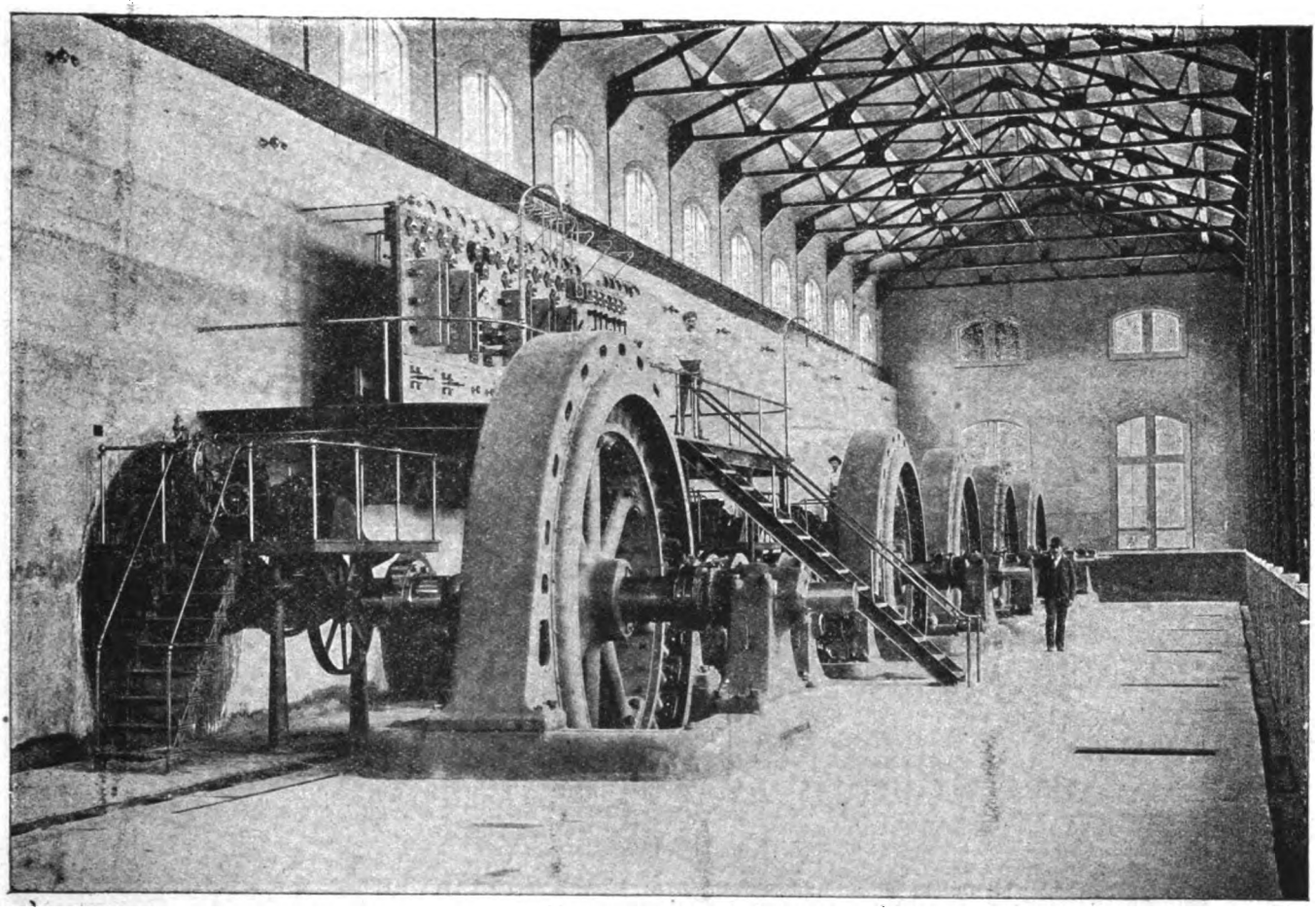
The Electrical Age.

VOL. XXII—No. 24 NEW YORK, DECEMBER 10, 1898 WHOLE NO. 604

POWER TRANSMISSION.



Interior of Power House, Mechanicville, N. Y.

ELECTRIC POWER TRANSMISSION BETWEEN DISTANT POINTS.

The various methods of transmitting power by means of steam, wire rope, compressed air and electricity have been carefully reviewed by some of the greatest living authorities. There was a time in the history of applied science when the selection of a system of transmitting power was a matter of the most careful consideration. A rapid review of the large installations at present in active operation will rapidly bring about a conclusion of a most definite and emphatic character. Electricity has assumed a position in the engineering world which gives it undisputed sway when the transmission of power over great distances is proposed. In our busy towns and less settled suburban districts the trolley has been a great success, and the distribution of power along these miniature transmission lines is increasing day by day until the consumption of electricity for lighting has become a perceptible item of the load at the power station. But power transmission proper between Niagara and New York or the coal fields of Pennsylvania and New York is an entirely different matter. In other words, the case that comes most closely in touch with the title of this article is one involving two widely separated centres between which a line is erected carrying power from one to the other. According to Kapp the efficiencies of a wire rope transmission plant are sufficient to explain why cable roads change to electricity. The reasons are plainly stated in the following figures:

Distance in feet.	300	1,500	3,000	15,000	30,000	60,000
Efficiency	.96	.93	.90	.60	.37	.13

From these figures the fact may be gleaned that wire rope transmission between widely separated centres is not an interesting proposition to capitalists. By sending elecricity tlirough a line over this system, which is at its maximum about twelve miles, the efficiency of its delivery would be about 72 per cent. at its best, and about 40 per cent. at its worst. It will be well to state for the benefit of our readers that a generator, line and motor possessing respectively 90 per cent. efficiency would give a result in efficiency for power transmitting purposes of 72 per cent It is not very difficult to send one thousand horse power to-day a distance of one hundred miles at an efficiency of 60 per cent. It is not difficult to attempt to transmit heavy power over long lines, neither is it impossible to send such pressures as sixty thousand volts safely a distance of twenty or thirty miles and deliver power with efficiency. The famous Frankfort-Lauffen

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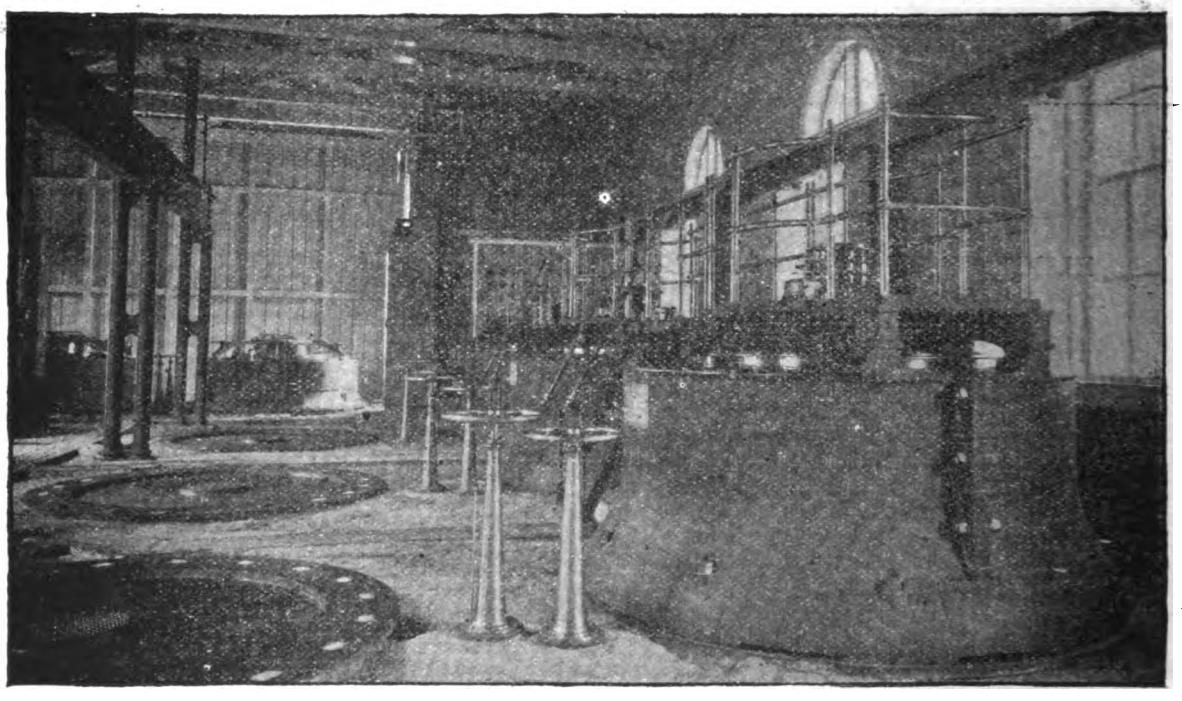
plant, which transmitted power from the Neckar River a distance of one hundred miles, is an example in which invite success. The transmission of electrical energy between widely separated centres becomes a

Interior of Electrically Driven Weave Room.

thirty thousand volts travel along the line. The efficiency is reported to have been 72 per cent. The economy of transmitting power is somewhat affected by the cost of repairs. Weak machinery is as detrimental to a plant as poor insulation. There are no continuous current generators in existence that could safely be used for high tension work—such pressures, for example, as ten thousand or twenty thousand volts; but a combination of the motor transformer polyphase generator and high-class insulators supplies elements that commercial problem of considerable significance. Lord Kelvin's rule for the size of conductors, Prof. Forbes' modification for the laying of an additional ton of copper and the citations of other authorities give us sufficient data from which to arrive at definite conclusions regarding the economical transmission of electrical energy. The transmission of power is successfully carried on with a high pressure and easy transformation, efficient motors and a good line insulator. Supplied with these at their very best and most practical values the



The Great Generators at Portland, Oregon.

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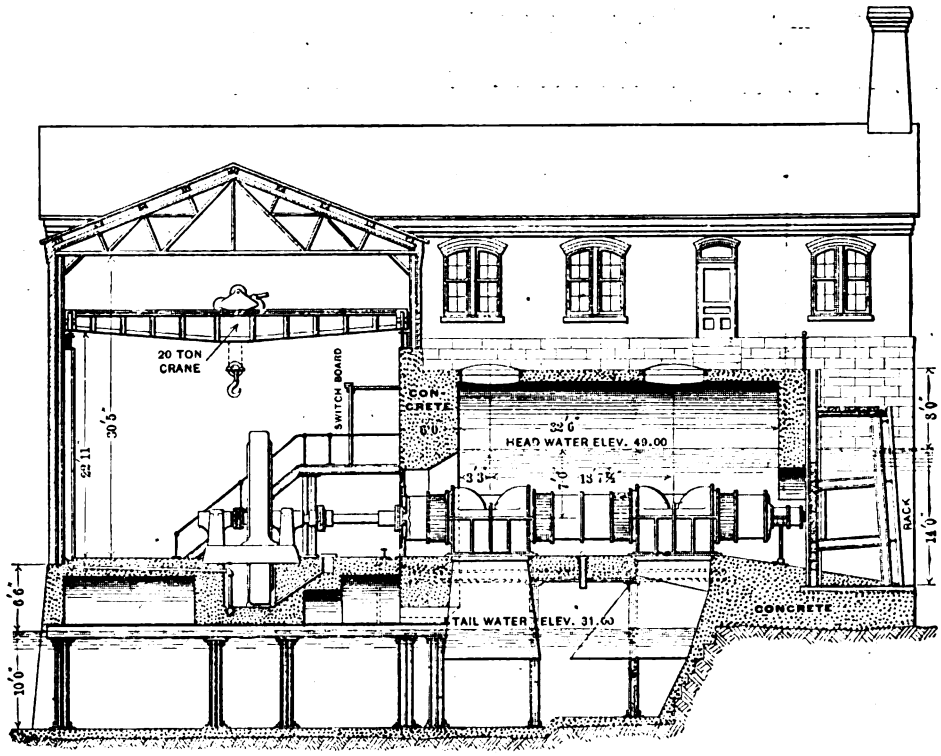
transmission plant can hardly fail to become a well-assured success.

CALCIUM CARBIDE IN EUROPE.—It is stated that the Schukert Electrical Company of Nurnberg in Germany has completed arrangements to have in oper-



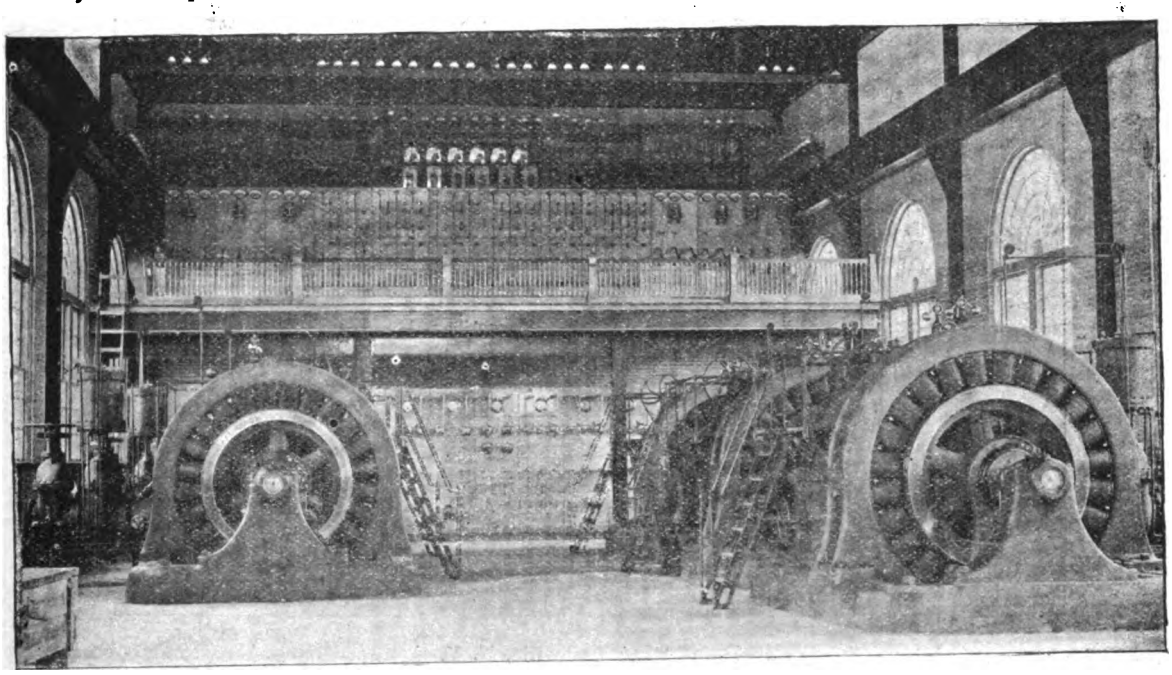
Section of Power House at Mechanicville, N. Y.

MISCELLANEOUS SCIENCE.

STRAY CURRENTS.

ARTIFICIAL RUBIES.—A patent has been taken out in Germany for the production of artificial rubies by evaporating a mixture of alumina and chronic oxide in the electric furnace and pass the vapors, with the introduction of damp air and hydrochloride acid, into a condensing chamber, where the rubies precipitate.—Ex.

ation next year plants for making calcium carbide in Norway, Bosnia and Spain; in all of these the electricity required will be generated by water-power. The total yearly capacity of these works will be 20,000 metric tons of carbide. In view of the proposed increase in production, it is stated that a reduction in price of 20 marks per 100 kgs. has been offered for next year, on contracts.—Ex.



Interior of Pioneer Power Station, Ogden, Utah.

MANUFACTURE OF VULCANIZED FIBRE.—Vulcanized fibre, which is extensively used by mechan-

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ical and electrical concerns throughout the United States, is manufactured in enormous quantities in Wilmington, Del. Of five plants in the country four are located in that city.—Ex.

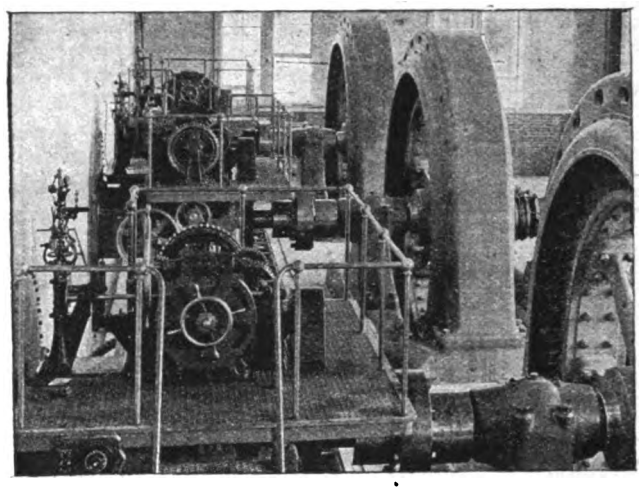
MAGNETIC ISLAND.—A magnetic island has been discovered in the Pribilof group, in the Behring Sea. The highest hill, Ulakiya, appears to be the centre of magnetism. The volcanic rock is decidedly magnetic, a noteworthy and significant observation.—Ex.

ELECTRICITY IN THE NAVY.—The Chief of the Bureau of Ordnance U. S. Navy, Captain O'Neill, says: "Experience has shown that guns in turrets operated by electric power can be laid upon and more accuracy made to follow a moving target than when operated by steam, hydraulic or pneumatic power. There are no water pipes to freeze, no steam pipes to burst, and no delay in obtaining a full working pressure, and no troublesome or noisy exhaust pipes to deal with. A burned-out fuse can be replaced quickly or a broken wire repaired, and as the wires can be led below the armored deck there is little liability of the latter becoming necessary."—Ex.

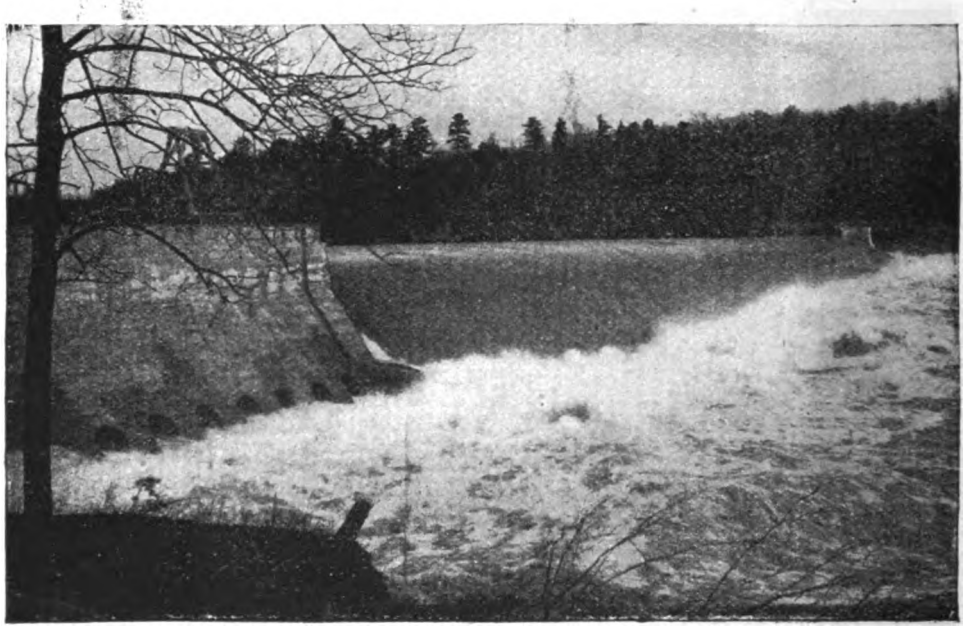
SINE WAVES ON OCEAN CABLES.—The Crehore and Squier synchronograph has recently been tested on the submarine cable of the Commercial Cable Company running between New York Ctiy and Canso, Newfoundland. A simple sinusoidal wave of impressed electromotive force is expected to give higher speed on cables with the same dielectric strain as it does on overhead lines with the same impressed electromotive force.—Ex.

Crescent City, Fla.—The Fruitland Peninsula Telephone Company has been incorporated, with W. J. Pierpont, president; Dr. G. E. Walker, secretary; J. W. Miller, treasurer. Capital stock, $800.

Jersey City, N. J.—Manhattan Microphone Company has been incorporated by John H. Mangham, Theodore J. Mitchell and Thomas A. Hutchins; for the purpose of making, buying, etc., microphones, telephones, etc. Capital stock, $100,000.



Governor, Mechanicville, N. Y.



Dam at Mechanicville, N. Y.

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THE EFFICIENCY OF MODERN TRANSFORMERS.

Some interesting problems have arisen of late in regard to the construction of transformers. By the term transformers the technical world generally refers to an alternating current device of the step up or step down order, quoting from Fleming as an authority, we find that he states that "the electrical efficiency of a transformer is defined to be the fraction or percentage of the whole energy supplied in a given time to the primary circuit which appears in the form of electric current energy in the secondary circuit." We can only attribute the present perfection of alternating current transformers or of any other form of apparatus by means of which the pressure of a line is raised or lowered to a more thorough comprehension of the elementary principles underlying the science of electricity and magnetism than existed in earlier days. The researches of Steinmetz on the subject of hysteresis, the labors of Ferranti in establishing a huge alternating current power transmission and distributing plant, the brilliant work of Tesla and Dobrowolsky in the field of power transmission by three-phase currents have stripped the science of the retarding influence of empyricism and thereby rendered the construction of not only transformers, but a great variety of alternating current machines, a simple and most definite process. However perfect a system of power transmission might be as far as the generator and line are concerned, the possibility of establishing such a system and making it a commercial success would be obviously impossible if the transformer itself possessed any inherent defects. An analysis of transformer reactions was carefully made by Professor Forbes, the recently deceased Dr. John Hopkinson, and Lord Kelvin, which brought to light many interesting facts concerning the output and economical operation of transformers in general. One of the conclusions arrived at was this: "For working economically with small frequency of oscillation large massive cores are essential, but by increasing the frequency the core mass may be diminished without loss of efficiency." The watts entering the primary coil and given out by the secondary in modern transformers differ but slightly from each other so high is the practical operating point of efficiency. Ninety, 95 and 97 per cent. are not any too high for the efficiency of well made transformers. The careful selection of iron, its proper lamination, the careful adjustment of the saturation point of the transformer and the practical means taken for rapidly dissipating any heat that may appear give in total a self-regulating, economical and exceedingly simple piece of machinery. Many of the scientific dissertations prolonging discussion through a course of weeks and sometimes months have ceased to be written on account of the definiteness that has attached itself to not only the phraseology employed, but to the meaning of certain phenomena inseparably connected with alternating current work. Such expressions as "square root of the mean square," "difference of phase," "hysteresis," etc., are not juggled with any longer, although there was a time when the use of such phrases implied a profound knowledge of the subject. But as use became abuse a general sifting took place through which many terms became obsolete and gave strength and vitality to that department of electrical engineering which lay entirely at the mercy of mathematicians and unprincipled inventors. Thousands of dollars are being invested each month in electric light and power plants. The great West, unknown to ourselves, has used its natural resources as far as possible for its development, and owes much of its life and modernness in its large cities to the use of electricity. But many plants installed there operate by machinery of the single or polyphase class, and we can rest assured that a deficient, troublesome, non-durable and unefficient transformer would have absolutely prevented either the introduction or use of what is now regarded as the most modern type of apparatus, the polyphase generator, transformer and motor.

ELECTRO-OPTICS.

A study of electricity in its higher branches becomes more and more a study of the fundamental principles of light. With so strange a medium as the luminiferous ether, the constitution of which is comparatively unknown, it is most natural for those sciences whose higher branches blend into the metaphysical to meet at some common point of intersection. Clerk Maxwell has outlined some of the physical conditions existing in the ether when certain electrical phenomena take place. In the study of light waves a certain similarity is observed in the treatment of the subject to that which throws light upon the finer foundations of magnetic, electro-static and electro-magnetic reactions. In fact, all branches of physical science become more clearly understood as spokes radiating from the same hub. Given ether and energy, and we can play upon the framework of matter through all of nature's keyboard and develop light, heat, magnetism, electricity, and possibly numerous undiscovered variations of these. At the point where light and electricity intersect a study of the ether begins, and it is hard to tell whether the mystery of the ether will be discovered by a co-ordination of these natural phenomena or whether a better knowledge of the ether must first be obtained before our horizon of scientific investigation can increase.

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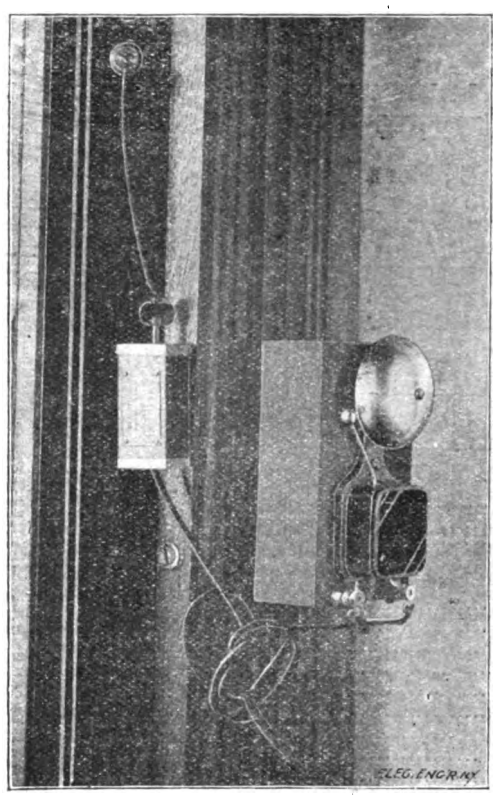
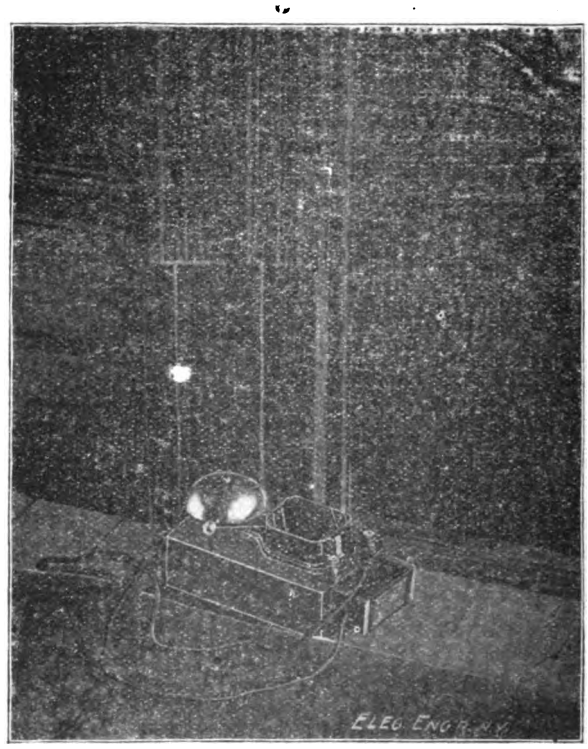
ELECTRICAL NOVELTIES.

A PORTABLE ELECTRIC BURGLAR ALARM.

The well-known contractor, Mr. Charles L. Eidlitz, the president of the St. James Electric Company, 1133 Broadway, New York City, manufacturers of the St. James burglar alarm, illustrated in these columns, realizes the practical value of this outfit as an effective, cheap and simple burglar alarm. It consists of a box containing two dry cells, to which is attached an electric bell wtih two and one-half inch gong. The signalling device proper is a small wooden cylinder, within which is a moving part insulated at one extremity by which means two springs are kept apart. The withdrawal of this moving separating piece by the opening of the door or window brings the springs together, closes the contact and rings the bell. This device is the acme of simplicity. Its action is positive, and can be understood by the smallest child. The readiness with which it can be adjusted, and its cheapness, make it an exceedingly popular article for domestic use as well as in factory, office or public building.



St. James Electric Burglar Alarm.



St. James Electric Burglar Alarm.

AN INDUCTION SEWING MACHINE MOTOR.

The Emerson Electric Mfg. Co., of St. Louis, calls attention to the fact that their improved induction sewing machine motor makes a useful and acceptable Christmas

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present for any housekeeper.

These motors, having no wearing part except the shaft, are particularly adapted for use by inexperienced persons, and the entire device is easily attached to any make of family sewing machine. The sewing machine is started, stopped, and speed is regulated by a slight movement of sewing machine treadle.

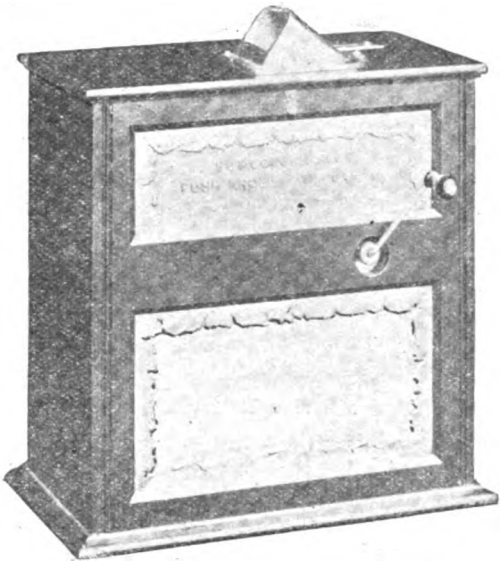
They further state that this is not in any sense an experiment, but is thoroughly practicable, fully guaranteed and sold at a low price. In order to fill orders promptly it is necessary to advise them as to voltage and alternations of current, direction in which hand wheel of sewing machine revolves, and style of plug for socket.

Hinton, W. Va.—The Hinton & Southeastern Telephone Company has been incorporated by A. J. Skaggs, James H. Miller, J. J. Swope, C. H. Skaggs, and W. H. Bonde. Capital stock, $50,000.

West City, Ohio.—Citizens' Telephone Company has been incorporated by James H. Miller, Leland B. Kent, Leon P. Charpist, Charles L. Arnold and W. M. Denman. Capital stock, $5,000.

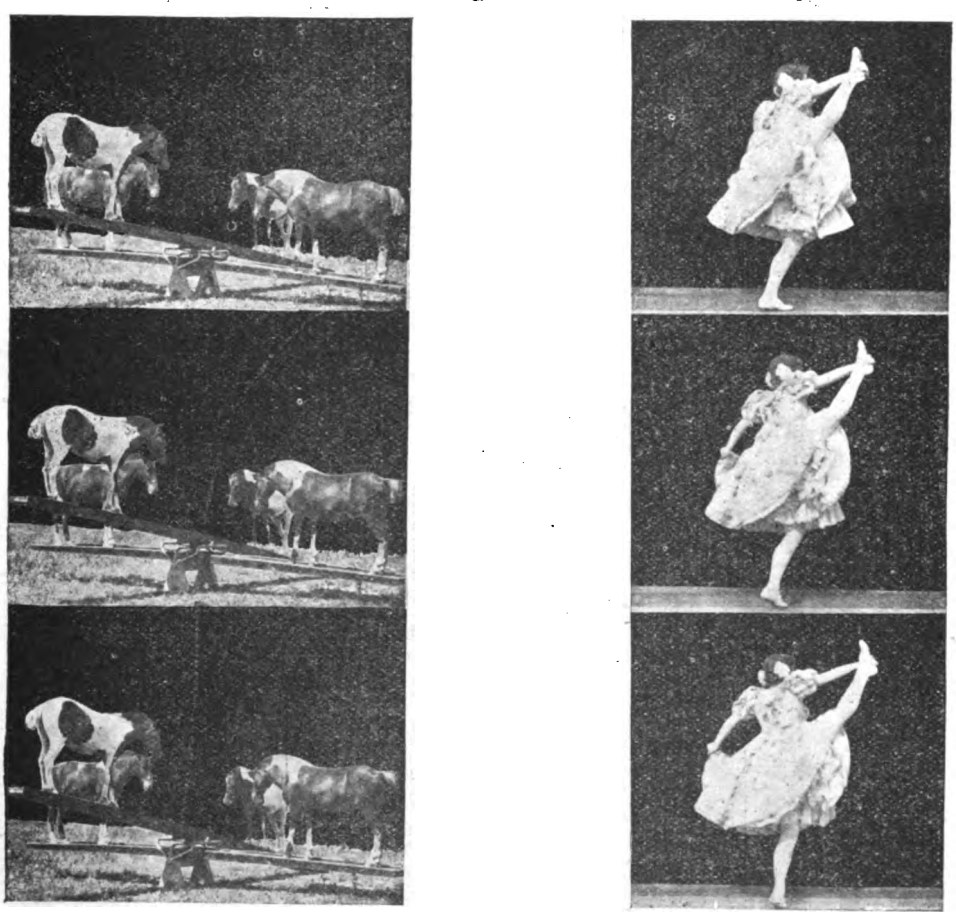
NOVELTIES OF INTEREST TO THE TRADE.

The parlor kinetoscope, illustrated in these columns,



The Parlor Kinetoscope.

is a machine in which lifelike reproductions are made, comprising a long list of interesting scenes. The pictures pass before the eye at the rate of eight hundred a minute, and represent in perfect miniature with absolute fidelity to nature pictures that for animation and life cannot be excelled. The parlor kinetoscope is exceedingly



Films for Parlor Kinetoscope.

cheap, and as a Christmas present would be regarded as a source of unmitigated joy by its possessor. By bringing to the home such means of amusement the younger as well as the older generation may be made familiar with events, countries, historical and other scenes that will remain ever fresh in the mind. The Edison Phonograph Agency, F. M. Prescott, manager, with offices and

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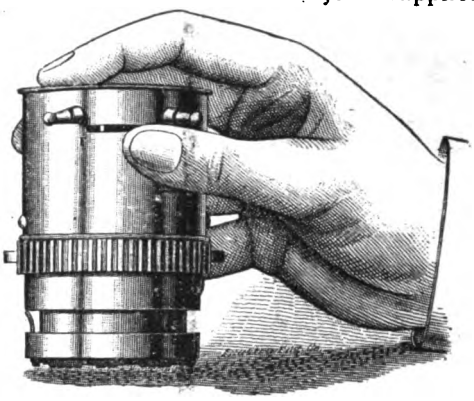
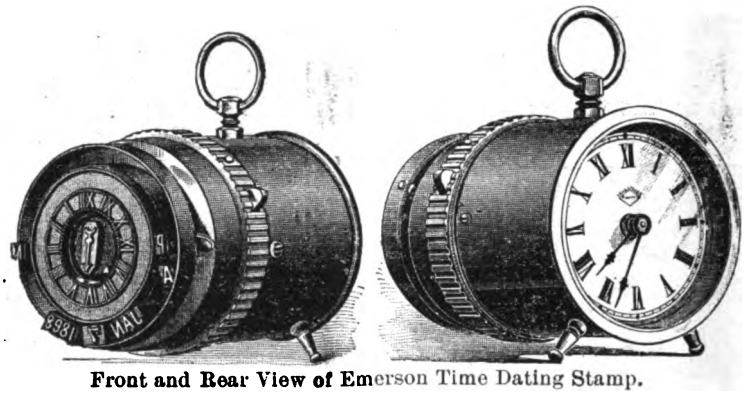
salesrooms in the Edison Building, 44 Broad street, New York City, have placed this exceedingly simple ——— upon the market with varieties of films sold at a very low figure to purchasers.

Time stamps have always been more or less a source of constant worriment to their possessors ever since their invention, and any time stamp, therefore, combining the elements of simplicity and reliability is sure of a hearty welcome in all places where an instrument of this kind is needed. The Emerson time-dating stamp, sold by the Edison Phonograph Agency, and illustrations of which are shown herewith, possesses all the elements of cheapness, simplicity and utility, and will therefore supply a long-felt want. As will be seen in the illustrations, the one end of the stamp represents an office clock, the other end being provided with a rubber dial and movable hands, with which the impressions are made. The hands on the printing end are connected with the clock centre in the same manner as the hands on the face of the clock and are therefore always in unison with the same. When an impression is made with the stamp, the time stamped is the same as that showing on the face of the clock. The stamp not only impresses the time, but also the day of the week, month and year. The clock is accurate and reliable, and will run forty hours with one winding; is not affected by the jarring caused by making an impression, as the mechanism is so constructed as to intercept any pressure.



Emerson Time Dating Stamp

The Penny-in-the-Slot Gramaphone is simple in construction, and consequently never becomes deranged; the sound it produces is clear and pure, and the range of subjects supplied with this machine cover a long and interesting list of popular songs, up-to-date music and various instrumental selections, as well as recitations, etc. The "Daily Mail," of London, speaks of the close of this century and the beginning of the next as the slot age. If this is true, one of the leading representatives of that age may be found in the form of the penny-in-the-slot gramophone.



Front and Rear View of Emerson Time Dating Stamp.

The Edison phonograph, whose fame has reached every civilized centre on the face of the globe, has been making rapid progress since its first sale on the market. Science has improved it to such a point of perfection that the timbre and volume of tone is a perfect facsimile of the original, whether recitation, a vocal or instrumental selection. The phonograph has become so popular that the merest tyro feels behind the age by not possessing one. It is unnecessary to state how much interest and amusement pertains to the use of a talking machine, but the proof of its extreme popularity is evident when an attempt is made to get a friend owning one to exchange it or sell. People owning phonographs keep them because

Penny in the Slot Gramophone.

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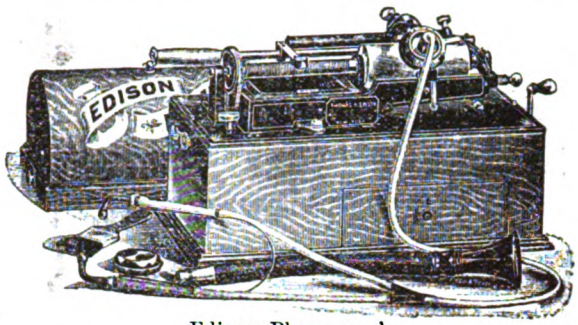
many family records are taken—records of social gatherings and the voices of the dead, as well as the living, who, as it were, can speak from the grave, years after they have rested in Mother Earth. This modern miracle performed by the phonograph makes it ever dearer to its possessor, and is as hard to part with as the family portrait. Mr. F. M. Prescott, the agent, will be pleased to receive visitors calling in reference to the above articles.

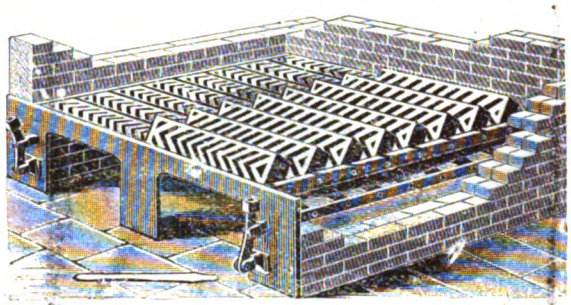


Edison Phonograph.

ELECTRIC LIGHT AND POWER APPLIANCES.

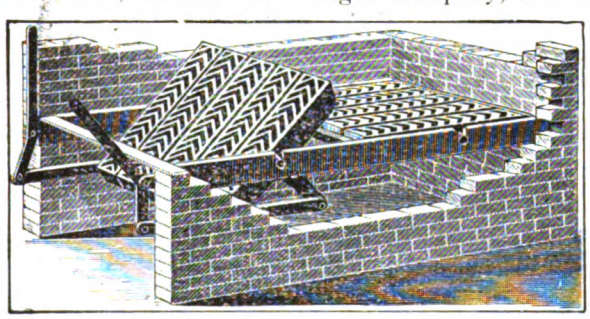
SECTIONAL GRATE AND GRATE BARS.

W. W. Tupper & Co., manufacturers of the patent sectional grate and gratebars for steamers, locomotives and stationary boilers, as well as grate bars for anthracite and bituminous coal, sawdust and shavings, have their offices at 39-41 Cortlandt street, New York City. They manufacture, in addition to the above, shaking and dumping grates, the great advantage of which is that they may be operated without opening the fire doors. The sectional grate and grate bars have been extensively used for many years. More than eight thousand cases are on hand and can be furnished to the customer of places where W. W. Tupper & Company have successfully installed their patent grates. Many steamers, factories and private plants fitted with these grates have been operating successfully for a period of over ten years. The grates do not warp or break. They are interchangeable and cheap. The largest as well as the smallest pea coal is equally useful for fuel with these grates.

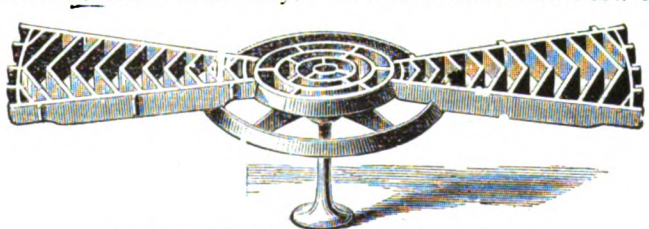


Rocking Grate.

The rocking grate, dumping grate and grate bar for the now Corliss & Manning boilers, illustrated in these columns, save thousands of dollars per annum to coal consumers. The grate problem of economy has been solved by the use of sectional grate and grate bars manufactured by the above concern. The electric light and power concerns, including the New Brunswick Electric Light Company, of New Jersey, and the General Incandescent Arc Light Company, of New York City, speak very highly of the sectional grate and grate bars installed in their boilers. Some few others having the same opinion are the United States Electric Light and Power Company, of New York, the Suburban Electric Light and Power Company, of Elizabeth, N. J., and the Lakewood Electric Light Company, of Lakewood, N. J.



Dumping Grate.



Grate for New Corliss & Manning Boilers.

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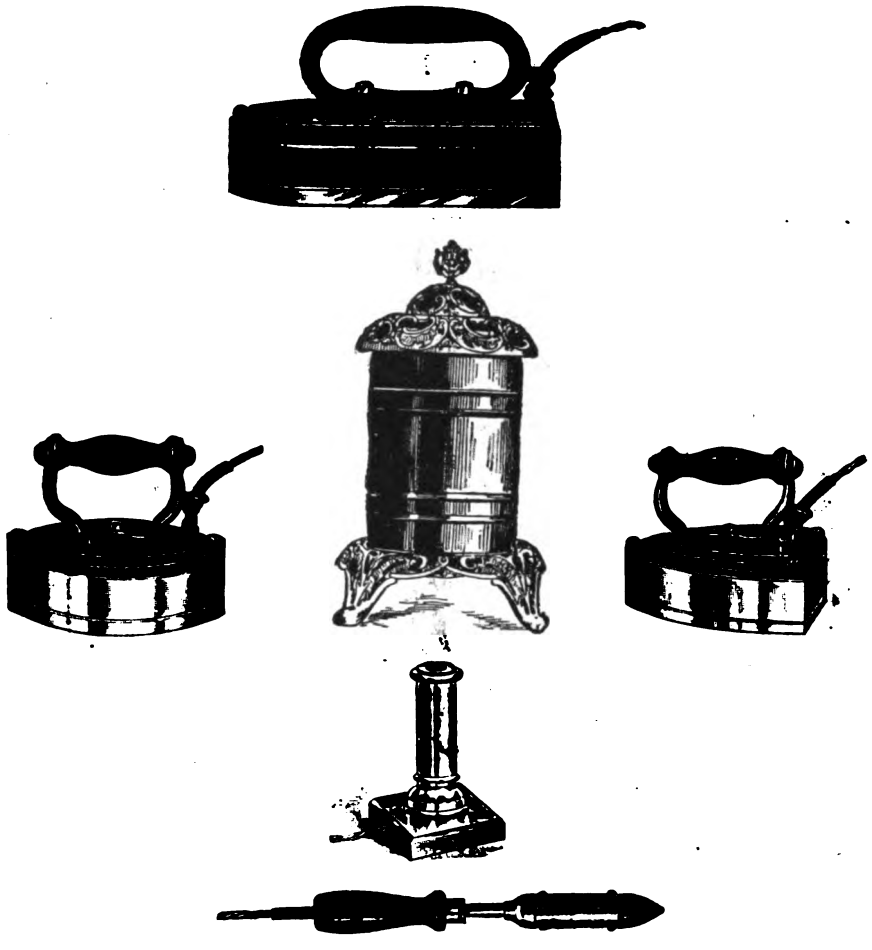
ELECTRIC HEATING.

ELECTRIC HEATTING DEVICES.

Those living in the twentieth century will enjoy many luxuries, among which will be found electric heating devices. The price of electric power is becoming less and less each year, and with this reduction is found a corresponding increase in the number of electric heating devices for domestic purposes. Electric irons for laundry work, soldering irons for the tinsmith, heavy electric irons for the tailoring establishments, electric curling irons for hair-dressers, etc., as well as electric heaters, are to-day articles of wide use. It is hardly necessary to refer to the advantage and convenience of these utensils, and it is obvious to the observer that power is only used when it is required. This in itself means a saving which cannot be effected by any other means at our command. To say that twenty years from date electric irons, stoves, and various other utensils will be in common use is not stretching a single point. It seems to be a foregone conclusion with those supplying electric power and those who manufacture electric heating devices. The American Electric Heater Company, of 197 River street, Detroit, Mich., have placed a line of these goods on the market. They are cheap, serviceable and will wear as long as the old-fashoined types, heated on the stove. To those interested circulars will be sent.



Heating Devices, American Electric Heating Co.

EXPOSITIONS.

THE 1899 ELECTRICAL SHOW.

Mr. C. O. Baker, Jr., president of the Electrical Exhibition Company, has signed a lease of Madison Square Garden for another electrical show, to be held during May, 1899, under the auspices of and in connection with the 22d convention of the National Electric Light Association. Although the last show occurred in May when the war interest was most intense, it drew large crowds of people. Electrical development is so fast nowadays and the newspapers have described so many of the newer and more wonderful inventions that an exceedingly interesting and successful show is looked for. The officers of the Electrical Exhibition Company are: C. O. Baker, Jr., president; H. L. Shippy, vice-president; Geo. F. Porter, secretary and treasurer; Marcus Nathan, general manager; H. H. Harrison, L. F. Requa, J. W. Godfrey and C. A. Lieb, directors.

At a meeting of the Board of Directors of The Electrical Exhibition Company, held Dec. 7, 1898, Mr. H. L. Shippy was elected a director and vice-president in place of Mr. F. W. Roebling, who resigned.

ELECTRIC LIGHTING.

HINTS FOR HOLIDAY LIGHTING FOR MERCHANTS.

The holiday season is upon us—the evening crowds upon the retail streets grow with each passing day, and more stores are open evenings. Now is the time when the merchant with brilliantly lighted show windows and artistically arranged displays has the advantage. It is interesting and instructive to note the difference in effect between windows lighted in the ordinary way with incandescent lights in full view, and those lighted by the Frink Store Window Reflector, where no lamps show, but where there is light in abundance. The comparison is unquestionably favorable to the Frink system, for exposed incandescents, by their greater brilliancy, distract the eye from the goods displayed, and often make it impossible to see the goods effectively. Oculists agree without exception that the source of light should be behind a person, or at his side, in order that an object may be seen with the least strain upon the eyes, and this car-

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dinal principle is recognized in the Frink system. It consists of a hood-shaped reflector, running along the inside of the glass at the top of the window. Inside the reflector the incandescent lamps are placed. The shape of the reflector shields these lamps from outside view, and reflects all the light within the window. Coming thus from practically over the observer, the light falls full upon the objects before him, giving an effect obtainable by no other method of lighting. Full information concerning this reflector may be obtained by addressing I. P. Frink, 551 Pearl street, New York.

AMONG THE SOCIETIES.

NEW YORK ELECTRICAL SOCIETY.

The 192d meeting of the Society will be held at the College of the City of New York, Lexington avenue and 23d street, on Wednesday, Dec, 14th, at 8 p. m. Col. Eugene Griffin, Colonel of the First Regiment of U. S. Volunteer Engineers, and first vice-president of the General Electric Company, will give an address on "Ideas Underlying the Organization of the Volunteer Engineer Corps; the Work Accomplished by it in Porto Rico, and the Opportunities of Further Usefulness." Mr. W. D. Weaver, late Chief Engineer of U. S. S. "Glacier," editor of the American Electrician, and Mr. F. W. Roller, late Chief Engineer U. S. S. "Nashville," will also address the Society on "Electrical and Engineering Work in the Navy During the War." In this manner the relations of the engineering profession to both the Army and Navy will be clearly brought before the members of the Society, and it is believed that the occasion will prove one of much general interest and value. The meeting is open to ladies.

BUSINESS NEWS.

SPECIAL EXPORT COLUMN—TOTAL ELECTRICAL EXPORTS FOR WEEK ENDING DEC. 6TH, 1898, $59,702.

New York, N. Y., Dec. 6, 1898.—The following exports of electrical material are from the port of New York for the week ending this date:

Alexandria—6 cases electrical machinery, $947.

Argentine Republic—6 packages electrical material, $481.

British East Indies—11 cases electrical material, $280.

British Australia—23 packages electrical material, $376.

Brazil—101 packages electrical material, $912

Berlin—3 cases electrical material, $60.

British Possessions in Africa—10 cases electrical material, $280.

Bremen—6 cases electrical material, $500.

British West Indies—3 packages electrical material, $150; 1 package electrical material, $12.

British Guiana—27 packages electrical material, $650.

Cuba—9 packages electrical material, $113.

Central America—1 case electrical material, $160.

Ecuador—1 case electrical material, $34.

Florence—1 case electrical material, $50.

Glasgow—18 cases electrical material, $1,438.

Hamburg—72 cases electrical material, $3,276; 12 cases electrical material, $3,345; 1 case electros, $25.

Havre—68 cases electrical material, $2,741.

Helsingfors—8 cases electrical machinery, $500.

London—212 packages electrical material, $7,124; 87 packages electrical machinery, $12,310.

Liverpool—8 packages electrical material, $1,893.

Leeds—11 cases electrical material, $367.

Mexico—40 packages electrical material, $1,837.

Milan—28 cases electrical material, $11,400.

Manchester—3 cases electrical material, $110.

Moscow—8 cases electrical material, $428.

Newfoundland—7 cases electrical material, $125.

Naples—5 cases electrical material, $255.

Oporto—36 cases electric motors, $5,600.

Preston—1 package electrical machinery, $10.

Stockholm—1 case electrical material, $386.

St. Petersburg—17 packages electrical material, $623.

Southampton—2 cases electrical material, $17; 18 cases electrical machinery, $343.

United States of Colombia—4 cases electrical machinery, $300; 2 packages electrical material, $17.

Venezuela—7 cases electrical material, $227.

BUSINESS CHANGES.

Worthington, Ind.—Worthington Light and Power Company has increased its capital stock to $9,500.

Philadelphia, Pa.—Technic Electrical Works, a corporation of the State of New Jersey, has made an assignment for the benefit of creditors to Richard L. Binder.

Jersey City, N. J.—The Crocker-Wheeler Electric Company, with a capital stock of $200,000, has been licensed to do business in Illinois.

POSSIBLE INSTALLATIONS.

Henderson, Tex.—The Henderson Electric Light Company will construct an electric light plant.

Seattle, Wash.—The Seattle power plant will be in operation by Jan. 1. The power is to be furnished from Snoqualmie Falls.

STREET RAILWAY NEWS.

Pittsburg, Pa.—Steps are being taken to construct an electric railway between Cadiz, Ohio, and neighboring towns, the line to be 22 miles in length and to cost $100,000.

NEW INCORPORATIONS.

East Chicago, Ill.—East Chicago Light and Power Company has been incorporated by George W. Wilson, H. N. Bailey and W. L. Pike. Capital stock, $15,000.

Sheridan, Ind.—Sheridan Light and Power Company has been incorporated by Charles S. Knight, H. C. Knight and W. L. Polhamus. Capital stock, $9,500.

Groton, Conn.—Groton Electric Company has been incorporated with a capital stock of $2,000.

Louisville, Ky.—Carter-Hays Electric Company has been incorporated by L. D. Curtis, E. W. Hays, H. C. Hays; to manufacture, repair, buy and sell electrical appliances. Capital stock, $5,000.

New York, N. Y.—Delaware Electric Light and Power Company has been incorporated by P. G. Stappens, D. McM. Niven, and C. W. Phillips. Capital stock, $250,00.

Clarendon, Ark.—The Clarendon Light and Heat Company has been incorporated, with J. W. B. Robinson, president; H. B. Bateman, vice-president; J. T. Jones, secretary and treasurer. Capital stock, $6,000.

Rockford, Ohio.—Rockford Electric Lighting Company has been incorporated by C. S. Mauk, A. G. Stewart, D. C. Kuder, F. M. Kirby, J. D. Wagers, and W. T. Palmer. Capital stock, $6,000.

Newark, N. J.—The Standard Automatic Lighting Company has been incorporated by Edmund K. Sargeant, Jr., Joseph Shetch, and R. Ten Broeck Stout. Capital stock, $100,000.

Norwich, Conn.—The Russell-Tomlinson Electric Company has been incorporated, with a capital stock of $20,000.

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New York, N. Y.—Paragon Fan and Motor Company has been incorporated by William E. Smith, Richard J. Scoles and Samuel Thorn. Capital stock, $15,000. Principal office, Washington.

TELEPHONE CALLS.

Smithfield, Tex.—The Isle of Wight Telephone and Telegraph Company has been incorporated by J. W. Thomas, J. W. Holloway, W. D. Folk, L. C. Brock, C. S. Betts, J. C. Goodrich, W. J. Edwards, J. U. Burgess and W. N. McAuge; to do a general telephone and telegraph business. Capital stock, $5,000.

Massies Mills, Va.—The Massies Mills Telephone Company has been incorporated by W. D. Meeks, James Dickie, J. C. Bentz, M. B. Hughes and others; to do a telephone and telegraph business. Capital stock, $2,000.

St. Peter, Minn.—St. Peter Telephone Company has been incorporated by H. P. Proctor, Augustus Proctor, Frank A. Chase, J. H. Chase and Walter S. Proctor; to construct and operate a telephone exchange and telephone lines at St. Peter. Capital stock, $10,000.

New Haven, Conn.—The Southern New England Telephone Company has mortgaged its property to the New Haven Trust Company, for $1,000,000.

NEW YORK ITEMS

Mr. F. B. CROCKER, of the Crocker-Wheeler Electric Co., 39-41 Cortlandt street, has left San Francisco on a business trip around the world.

THE NEW JERSEY VALVE CO., 120 Liberty street, solicit correspondence regarding their "Security Fog Signal," a new form of electrically controlled whistle valve. A description of this valve will appear in an early issue of the "Age."

Mr. MARTIN J. INSULL, the well-known electrical engineer of Chicago, will be in town this week on business.

C. H. KIRKLAND, 129 Greenwich street, has been appointed New York manager for the Bibber-White Company, of Boston, manufacturers and dealers in insulated wire, electric light and power supplies, etc.

S P. DENISON, electrical expert and model-maker, and well known as the inventor of writing telegraph apparatus, is gradually recovering the use of his right side, which was paralyzed through a bicycle accident over a year ago. Mr. Denison's office and works are located at 143 Centre street.

ARTHUR WARREN, the advertising manager of the Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa., is in town.

W. S. BARSTOW, the well-known general superintendent of the Edison Electric Illuminating Co., of Brooklyn, has been appointed general manager of the Kings County Electric Light and Power Co.

THE NORTHERN ENGINEERING COMPANY, of 39-41 Cortlandt street, is composed of Messrs. George C. Hoffman and Theodore W. Kloman, two electrical engineers of considerale note and prestige. These two gentlemen have been associated with some of the largest electrical engineering and contracting firms in the country and have been very successful in installing large isolated plants for electric light and power. Through their energy and hustle for business they have made themselves very popular, and on this account they were singled out by the Northern Electrical Manufacturing Co., of Madison, Wis., and appointed their Eastern managers. They have added to their stock of electric power specialties by becoming the licensees of the Electrical Appliance Company, 27 Thames street, makers of the well-known gravity motor controllers for elevators, pumps, etc. The Northern Engineering Co. will manufacture and sell these controllers in the United States and Canada. Mr. G. A. Nesbit, the former manager of the Electrical Appliance Co., introduced and popularized the graviay motor controller, and Messrs. Hoffman and Kloman, through their knowledge of the business, will undoubtedly place this specialty in its proper sphere. They are placing some excellent contracts, and have already sent a number of large orders for dynamos and generators to the home office, surely a good showing for a firm only a few months old. The Northern Engineering Company are also the Eastern agents for the Warren-Medberry Co., the manufacturers of the inductor type of alternating dynamos.

WESTON STANDARD ILLUMINATED DIAL

STATION INSTRUMENTS.

THESE INSTRUMENTS are based upon the same general principle and are just as accurate as our regular Standard Portable Direct Current Voltmeters and Ammeters, but are much larger, and the working parts are inclosed in a neatly designed dust-proof cast-iron case, which effectively shields the instruments from disturbing influences of external magnetic fields.

WESTON ELECTRICAL INSTRUMENT CO.

114-120 William St., Newark, N. J., U. S. A.

75c. "VULCAN" STYLOGRAPHIC PEN. 75c.

"INDEPENDENT" FOUNTAIN PEN.

PRICE, WITH ENGRAVED HOLDER, $2.00. SAME WITH GOLD BANDS, $2.50.

Fountain Pens licensed under Patents 261,134 and 311,554.

Send for our New Catalogue and Discounts.
AGENTS WANTED.

J. K ULLRICH & CO., 27 Thames St., New York.

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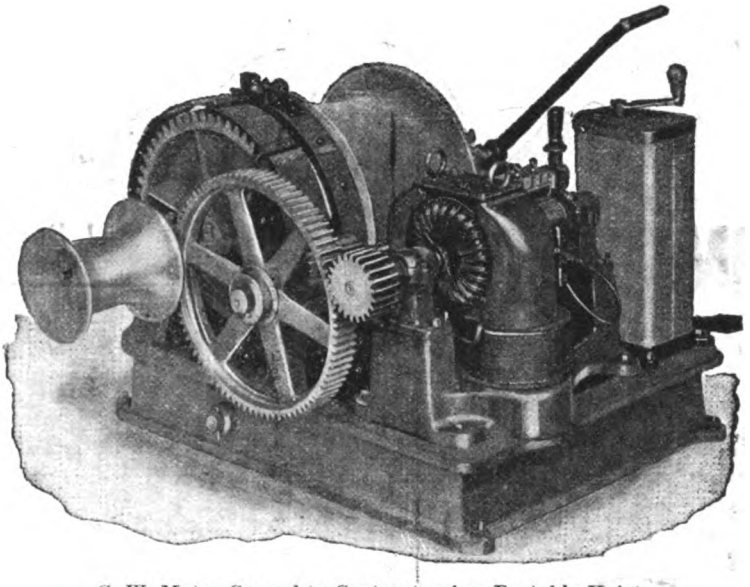
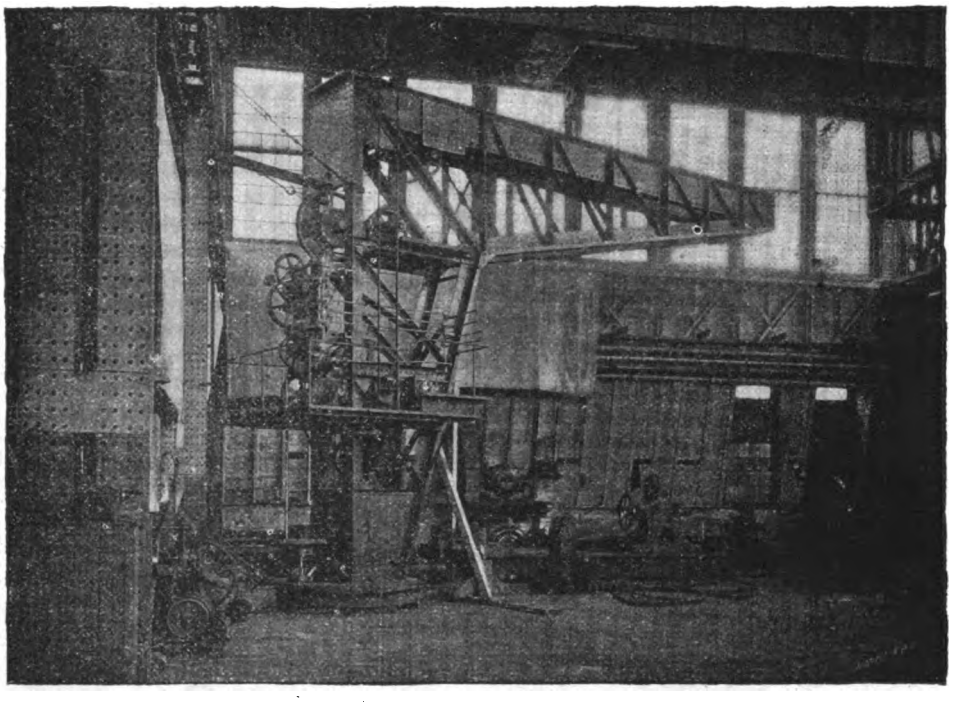
The Electrical Age.

VOL. XXII—NO. 25 NEW YORK, DECEMBER 17, 1898 WHOLE NO. 605

ELECTRIC LIGHT AND POWER.



C.-W. Motor Geared to Contractors' or Portable Hoist.



C.-W. Motor Geared to 15-ton Sellers Jib Crane, Cambria Iron Co.

ELECTRIC PUMPS AND HOISTING MACHINERY.

The progress of modern engineering has been stamped with certain characteristics which relate mostly to a saving in time and rapidity in execution. A machine may operate quickly but before it is ready to accomplish a given amount of work more time may be spent than by the old-fashioned methods of procedure. The art of engineering therefore calls largely upon the time element, other things being equal. Modern mining has rapidly assumed a position in the field of industrial activity so as to apply to itself all that is true in other fields of engineering. Pumping and hoisting are not necessarily integral parts of mining practise. Such machines are required for so great a variety of purposes that it would be difficult to limit its scope of usefulness to one particular field. Since the advent of the motor and the establishment of its success and proof of its ability to compete in the open market with other power producing devices its application to innumerable machines, such as pumps, hoists, etc., has

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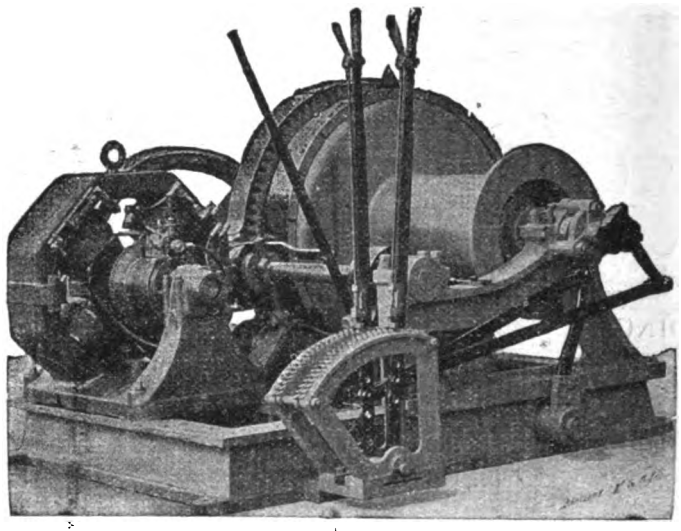
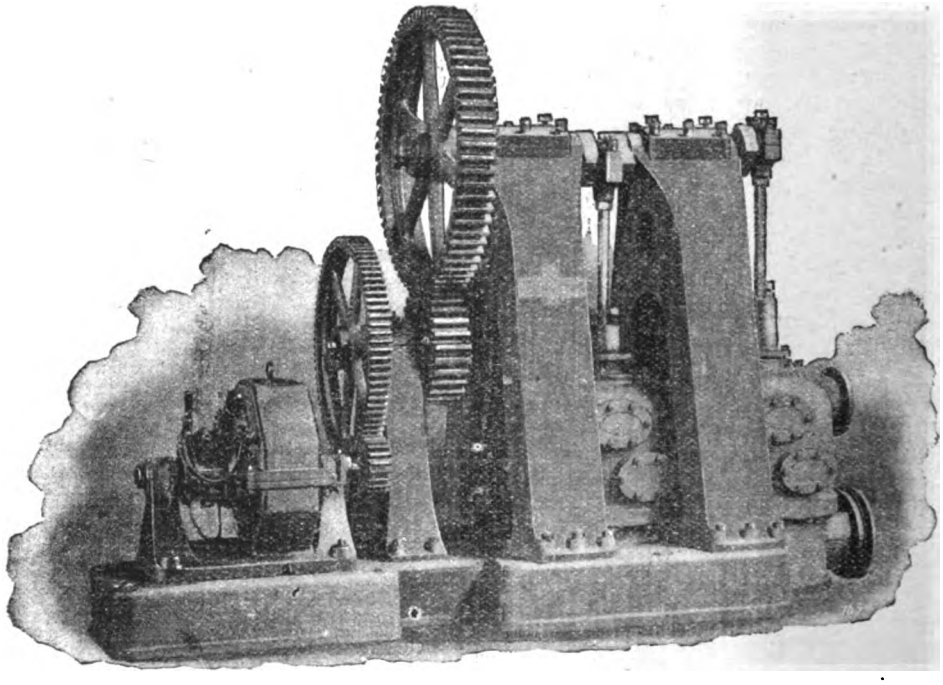
become an accomplished fact. The tide of change flows in slowly but it effectually drowns old-fashioned and expensive methods. Electric hoists and pumps and even great cranes, such as shown in the illustration, in mining



C. W. Motor, Geared to Two-Speed Skull Cracker Hoists.

and manufacturing are successfully driving out their steam-driven predecessors. The Crocker-Wheeler Electric Company manufacture complete outfits for general mining and foundry work. The design of the motors and



C. W. Motor Geared to Worthington "Steeple" Pump.

their connection, as shown with the machines they operate, is of such a character that a minimum of power is lost through friction. The electric pumps, of course, are simply motors geared to pumps of high-class make. By this system of connection the natural speed of the motor does not call for special low speed machinery, which is generally larger, heavier and more expensive than in this case, i. e., a fairly high speed motor geared and doubly reduced operating the pump. Power transmitted this way obviates many of the most disagreeable features of construction. It reduces the waste of power and really increases the capacity of the machine without affecting other important factors. Uniform speed naturally results and a steady and powerful stream of water may be kept flowing for hours and even days at a time. The electric hoists and cranes belong to the same class of machinery.

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There is a moment at which the strain upon the motor is exceedingly great, and in consequence of this their design is of such a nature that a temporary overload causes absolutely no injury. A great mass that is swung into the air from a condition of rest does not realy call for an instantaneous effort on the part of the motor, because time is consumed in leaving the ground as well as reaching it. The proposition is therefore not a difficult one. The motors applied to these hoists will lift a given weight at a given speed per minute or a greater weight at a proportionally lower speed. Inured against moisture, durable in construction and highly efficient in their consumption of power these combinations have gained greater and greater popularity, sufficient, in fact, to make their general use in shops, mines and factories an absolute certainty.

COMMUNICATIONS.

ADEQUATE FIRE PROTECTION FOR HIGH BUILDINGS.

A fire lately occurred on Broadway involving an old-style low building and a modern fireproof skyscraper. The Fire Department sent rattling along its antiquated paraphernalia, but on account of a high wind, it was unable to control the fire in the low building; and because some inspectors were delinquent in their duties in not having the skyscraper provided with fireproof window shutters, the latter caught and burned out the interior of its upper stories. The Fire Chief did the best he could with his liliputian apparatus. His little steam squirt guns, on wheels, puffed and snorted; his Siamese pipe-stem of a perambulating water tower could not be lengthened seventeen stories high, and so he called more funny little squirters and towers to his aid. But all the Chief's horses and all the Chief's men could not effectively squirt higher than nine stories. The Chief saw the ridiculousness of his primitive efforts, for he is quoted as saying: "Let her burn, boys!" An extended conflagration might have ensued as far as the Department was concerned had not the fireproof structure stood like a mighty bulwark and fire-wall to protect what was beyond.

Old-method "authorities" now tell us a law should be passed prohibiting buildings from being over a certain limited height in New York—all because the Fire Department's apparatus has not kept step with the changed modern building construction. A little later some other "authorities" from sleepy Philadelphia—where grass is supposed to grow in the streets—came to view the ruins, and they also evoked a new law limiting building heights, and imply as well that modern progress must be jerked back to the limits of their old claptrap fire-fighting apparatus. They do not even concede that fire-extinguishing methods can be made to conform to the changed building construction.

The whole thing is a farce, worthy of being treated by a Cervantes or a Dean Swift.

It took Chicago to build a World's Fair that surpassed the best European effort. Our city's best effort in this line has been the old Institute Fair "food exhibits" at the Grand Central Palace, Madison Square Horse Show, and Barnum's circus.

San Francisco and Kansas City had cable street railways about the same time that our Broadway had a horse-car line, and even this line was fought so hard by the Hebrews along the route, who frothed at the mouth and frantically gesticulated their wrath, and called on Moses to witness the sacrilege, that the city crucified poor Jake Sharp for employing the only means—bribery—to give the city this great benefit.

It is hard for a man to be progressive and honest and succeed in this city.

Chicago has used electric traction on her elevated roads several years, and we are still enduring the discomforts of sulphurous fumes, cinders, ashes and dripping hot water.

We were copying the Prince of Wales' clothes and London stage coach locomotion long after Western cities had electric traction.

Chicago, Milwaukee and little Akron, Ohio, had their electric wires underground long before we conceived the practicability here. The same with the improved fire and police telegraph methods; and it is the same with nearly everything else.

We are the true mossbacks, and have much to learn in fire-fighting methods from the energetic, wideawake, wild and woolly West. Even the supple, strong convenient, economic, safe, fire-proof, modern, steel-frame skyscraper we copied from Chicago. Our architects and capitalists were pessimistic on the subject long after their worth was proved in the West.

All experienced traveling men know that a fast express train is safer than traveling on an accommodation or a freight train, and for much the same reason a skyscraper is safer on account of the great skill and the best of material used in construction.

Whoever heard of the necessity of shoring up one of these buildings to keep it from tumbling down, like the low, flat Rothschild building in Brooklyn?

Instead of laws limiting the height of building, called for by the New York and Philadelphia fire chiefs, we should require laws compelling the building of nothing but skyscrapers along the blocks facing Broadway, in the place of the low buildings that are the true sources of conflagration.

Whoever heard of a serious fire originating in a skyscraper?

Two parallel blocks of rows of skyscrapers from the Battery to the Harlem River would prove an efficient fire-wall, extending along the backbone of Manhattan Island, to prevent an extended conflagration in a high wind, such as devastated Chicago before they were built in that city.

The more twenty-five and forty-story buildings, the better; blow up the old rathole firetraps that disgrace our main thoroughfare, and allow us to become a representative modern city.

If our burnished toys of perambulating steam squirt-guns with their water towers cannot squirt higher than nine stories, they are evidently of little use under changed modern conditions. Relegate them to Goat Town, or keep them for holiday parades, when the old volunteers drag their little hand-pumps along in memory of ancient times.

The next step will be as drastic as it is important—sweep out the whole official personnel of the present Fire Department, commissioners included; for it is not worth the pains to teach old dogs new tricks, and it is as impssible to reform confirmed old mossbacks as it is to rejuvenate old maids.

Then send West for energetic, up-to-date, resourceful young men who have ozone in their blood—the same breed that made the World's Fair a success, and empty-handed built up her commerce and her industrial successes, and who are all devotees of the Western Goddess, "I Will," to replace the old "Has Beens" who want the world to stand still because they can no longer keep up with modern progress.

Then get some more of the same ilk from the same place—for we cannot find them here—who will inspect buildings during their construction, and not after they have fallen down or burned up; for we have too many Buildensiecks and Rothschild structures. Open boasts have been made by contractors that any of the present building laws can be, and have been, violated for a consideration.

The next problem to be solved is to make each skyscraper its own stationary water tower for its individual

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purposes, and also to drown out fires in surrounding buildings, even those across the street, and to water-soak any insignificant tinderbox structure that may be on fire below.

Then construct permanent stationary means to conduct plenty of water to each building, independent of the present over-taxed water system, and then to provide means to get the water to the place needed with sufficient force.

To Western people the solution of these problems would be simple, easy and quick of practical solution. But to the old fogy mossbacks and time-servers in charge of our Eastern municipal departments, I doubt the possibility of the change unless we place the ideas on their heads and drive them clear through their cobwebby intellects with an axe; for their only originality consists in pulling down the buildings that are the pride of our city, in order to bring their roofs within the reach of their grovelling intellects and their little puffy old steam squirt-guns.

The tall buildings of Western cities are provided with two or more stand-pipes reaching through to their roofs, to which two or more engines may be attached to each pipe when necessary, and the water pumped in solid, unbroken streams, unaffected by prevailing winds, to any desired heights; and in certain sections of these cities hose carts do not accompany an engine.

Other cities, like Detroit, have laid underground conduits from the river, independent of the usual water supply system, and a powerful fire-boat forces the water to the desired locality, and may be operated, if desired, in conjunction with the stationary stand-pipe, with or without the assistance of the usual fire engine.

Few of our buildings are provided with accessible stand-pipes, and we are unable to avail ourselves of the admirable river fire-boats for inland purposes. Our only auxiliary to the toy fire engines is a water tank on the roof that seldom, if ever, is full, or holds enough water, or gives adequate pressure where and when most needed; or a pumping apparatus in the basement, that is of little use on account of the time to get it in operation, or is of sufficient capacity. Both of these aids, practice has shown, are quite impracticable and unreliable.

There is probably no city in the world so admirably situated as New York for adequate fire service to meet modern requirements. For, situated on a long, narrow island, completely surrounded by water—and salt water at that—we have ideal conditions for an ideal installation. We may even banish hose carts, water towers, and engines on wheels, and stop killing our citizens and the firemen (who are often strapped to their seats) in their mad career through our streets; sell our engine houses and take our firemen to fires in comfortable patrol wagons unaccompanied by the deadly juggernauts of dangerous fire apparatus.

This may be done by building underground parallel pipe lines at convenient distances apart from both the East and North rivers toward Broadway, with suitably situated and accessible valves to prevent undesired intercommunication.

These pipe lines could be connected to commodious stand-pipes in each building, and each floor provided with hose, and each fourth floor provided with pipes branching toward the exposed sides of each building from the stand-pipe, and provided with a dirigible nozzle toward the streets and areaways.

The river ends of each pipe would be provided with from three to five Siamese connections, to which the same number of fire boats could be connected. It will then be possible to generate a water pressure that will blow the very skylights out of a fifty-story building; and if five fire boats cannot do it, connect the stand-pipe with five other fire boats from the other river.

A fire on any floor of a building thus protected may be fought from within by half a dozen streams of salt water, and from without with as many more from adjoining buildings, especially from across the street; and if any tiny steam fire engine wheezes its protests, it could, by these means, be washed into the bay.

If it be economical to build skyscrapers, it will pay to protect them.

This system may find other very economical uses—such as flushing the sewers, sprinkling and sweeping the streets, melting snow and quelling riots.

The construction of a complete system of fire protection for Manhattan Island, substantially of the character described, would give us facilities far ahead of anything in the world. Then why wait for Oshkosh or Kalamazoo to set examples for us to follow like imitative monkeys, or adopt some little wrinkle from a jay town out West, when nature has given us advantages enabling us to be leaders and grandly systematic and progressive? As a city we should be admired and imitated for our progressiveness, instead of ridiculed for our conservative, servile imitations and antiquated, ineffective fire system.

The upper part of the Island being much wider than the lower part, and the centre being forther from the river on each side, we might require an auxiliary system, in case sixty-story buildings should be built in Harlem. When that time arrives, we will be duly prepared to master the situation by installing at convenient distances throughout the buildings, compact, efficient, direct-connected electric rotary pumps, taking their power from those unfailing sources of supply—the electric light and electric railway circuits, or both conjointly to insure positive results. This auxiliary system would help out our parallel pipe system, as outlined above, and compensate for the water friction in the additional length of pipe lines, and the added heights of the stand-pipes, and in case of accidents of any nature, these electric pumps could be connected with the present water system.

Our present water system is, from recent examples, too glaringly inadequate and out of date; and even though my suggestions are adopted finally by the city, it will take our municipal fathers and heads of departments so long to get their commissions agreeably adjusted, that I would seriously advise the owners of our skyscrapers to place no further reliance on the senile Fire Department, or await the tardy action of the commissioners in the matter; but take immediate steps to instal the electric pump sysem, as outlined for emergency purposes, and thus be independent of municipal incapacity and procrastination. The chief points in its favor are its quickness, facility and cheapness of the installation and operation. It requires no skilled attendance, other than the intelligence of turning a switch lever or a rheostat handle, and requires no addition to the present building employees. No steam boilers or additional machinery will be required. In fact, the system will be independent in all respects from existing apparatus, with practically no expense after installation, except interest on cost price, and for electric current in case of fire, and possibly no appreciable extra piping, as the pumps could be connected directly to the existing water supply pipes.

This will be the most efficient makeshift possible until a dozen more million-dollar fires thoroughly accentuate the utter worthlessness of our fire system, and a long-suffering public get thoroughly aroused and demand radical improvements.

Cheraw, S. C.—The New England Electrical Company has been incorporated by W. E. Price, E. A. Palmer, G. T. Nicholls and W. P. Pollock to engage in a general manufacturing business, electricity not being mentioned. Capital stock $250,000.

East Orange, N. J.—Standard Automatic Lighting Company, incorporated by Edmund K. Sargeant, Jr., and others, to erect light plants. Capital stock $100,000.

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FIRE PROOF SKY-SCRAPERS.

The punishment of Prometheus for stealing fire from heaven was the perpetual agony of having his liver devoured by an eagle. If it were not for this the necessity for fire proof buildings would never have existed. The sufferings of Prometheus cannot be one iota to those of a large fire insurance corporation that insures a so-called fire proof building and then discovers too late that they had dealt with a delusion. In a recent editorial the subject of fire was considered from quite a different standpoint. Fire protection engineering, as it may be called for want of a better name, takes into consideration the possibilities of fire, not only through an external cause, but due to a conflagration resulting from the dangerous proximity of steam pipes, gas pipes, electric light wires, electric light machinery, etc., to things combustible. The general arrangement of the necessary appliances of a modern office building, or in fact of any other building, should be such that the risks of fire determined by a scientific method of investigation are reduced to an absolute minimum. The habit of putting up tall buildings has grown upon the people of our most progressive American city. They are generally better buildings and certainly more comfortable and in general safer than those of an older type, but the chances of their becoming a gigantic blazing torch, as per the case of the Home Life Insurance Building, are certainly increasing, and unless means are taken to prevent the re-occurrence of such an accident, hundreds of lives will pay the penalty of this neglect. It is true that like the polyps of the Southern seas we rise by building upon the bodies of the dead, and all modern progress has been due largely to such sacrifices. Yet are they necessary? It seems not unless we lose confidence in the efficacy of our fire alarm corps and their appliances. It is very likely, and, in fact, extremely probable, that the damage done to the Home Life Building would have been avoided by the use of iron shutters on the windows, automatically controlled by electricity, so that at the mere suggestion of a rising temperature outside they would fold tight. Another suggestion is that certain iron posts be provided with electrical connections for the purpose of forcing up to any height a stream of water ejected from a powerful electric pump, perfectly portable, supplied with the proper length of hose and owned by each large office building in the city. Whereas it is the evident intention of proprietors of large office buildings to have them constructed so as to be immuned from fire, still great dependence is placed upon the city fire engine corps. The buildings themselves ought to be provided with appliances for putting out a fire, and a weekly or monthly examination made by a responsible city board to see that such devices are always in good working order. It seems certain that the inspection of elevators is not more important than that of the building itself, not to discover whether it is safe from fire risks, but to see that it is provided with means for quenching the flame instantly wherever it may arise. Electrical inventors can take the hint at once.

TRANSATLANTIC TELEPHONY.

This question periodically arises and seems to bring with it an influence of so fascinating a character that however often the problem may arise there will always be some ready to solve it. The lay mind regards this colossal project as one of an extremely simple character, the reasoning being, "If we can talk across the continent, why can't we speak across the ocean." It is hardly necessary to rehash the technical reasons why transatlantic telephony is at present impossible, but we can say with a certain degree of confidence that is not based upon faith that its accomplishment will not be deemed an impossibility until proven so. The unfortunate effect of electro static capacity in a cable and the difficulty of neutralizing it makes many scientific men feel that the problem is beyond them. If a system of automatic telephone repeaters were installed tightly cased at the ocean's bottom every hundred miles or so it is very likely that speech might be attempted. But this is grasping the bull by the horns, accepting the difficulties and not seeking to remove them. It is certainly more scientific and satisfactory to attempt to remove electro static capacity by building a cable coiled as it were for the purpose of giving it a uniformly distributed self induction which might remove much of its capacity. The idea of Edison to establish a line of repeating stations anchored permanently is extremely practical as compared with other suggestions, but unless the art of transmitting speech is absolutely changed by the development of a new system transatlantic telephony is an alluring ignis fatuus.

Brazil, Ind.—Electric Haulage and Manufacturing Company has been incorporated by James H. McClelland, Edmund C. Morgan and Charles B. Nibbloch to manufacture motors and machinery. Capital stock $10,000.

Williamsport, Ind.—Williamsport Water and Light Company has been incorporated by John H. Brown, B. O. Mayer and George Mayer to operate a water system and furnish electric light. Capital stock $10,000.

Bradford, Ill.—Bradford Electric Light Company, incorporated by Robert Thompson and others; electric light, heat and power. Capital stock $10,000.

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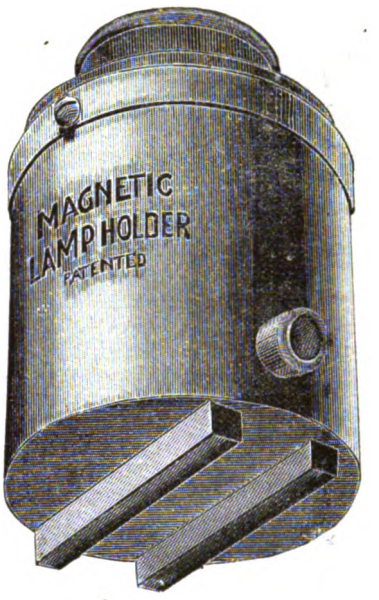
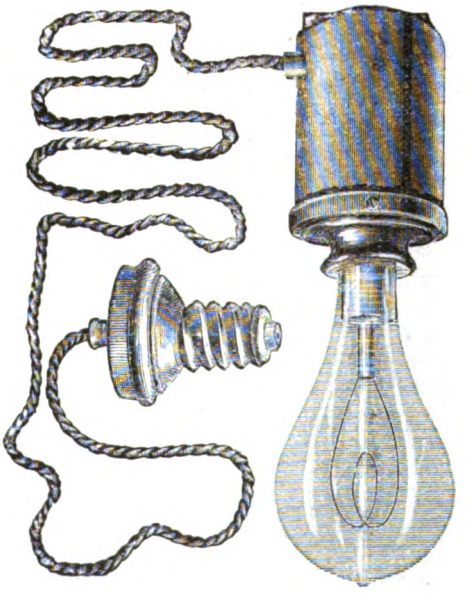
ELECTRIC LIGHT AND POWER APPLIANCES.

THE MAGNETIC LAMPHOLDER.

One of the most unique and absolutely novel devices on the market is being manufactured and sold by Jenkins Brothers, 71 John street, New York. It consists of a socket for an incandescent lamp containing an electro-magnet through which the current circulates and thereby magnetizes the lampholder sufficiently to make it adhere to any piece of iron or steel work. The magnetic lampholder, as it is called, will hang on to a machine tool, such as drill press, planer, lathe, etc., either at the head stock, tail stock or any part of any other machine in any position desired. In boiler shops, railroad shops, in mines, basements, cellars, bank vaults, in fact, wherever there is a square inch of iron to stick it on, this lamp will find a resting-place, hang tight, and give all the light just where it is wanted. One direction must be observed is to never turn off the current before holding the magnetic socket in your hand. Whoever invented the magnetic lampholder had an eye to business that was particularly keen. This holder will certainly meet with universal use and its inventor will be silently blessed by thousands of machinists who sometimes do poor work for lack of good light.



Jenkins' Magnetic Lampholder.



Jenkins' Magnetic Lampholder, with Lamp Attached.

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GENERATORS.

THE WING ACETYLENE GAS GENERATOR.

With the introduction of acetylene gas as an illuminant for general use, there arose a demand for a suitable generator for the same; a generator which would combine the elements of compactness, simplicity and safety. By combining these factors a generator would result which could be operated by the ordinary mortal without the fear of being spread sectionally to the four winds, this form of demise being the popular conception of the fate of any person rash enough to experiment with the sun's latest rival for illuminating honors.

The Wing acetylene gas generator has been designed for general use and combines in itself all the elements necessary in an efficient and safe generator. Among a few of its most noteworthy features are the following:

Wing Acetylene Gas Generator.

1. The generator is self-contained, there being no outside carbide holders, water tanks, coolers or complicated systems of valves.

2. Small space occupied for number of lights supplied.

3. The carbide holders are small and easily charged or emptied.

4. The carbide holders are closed with screw and gasket, similar to steam joints, and are therefore absolutely gas tight.

5. The gas is cooled and purified as rapidly as made and therefore is dry and free from all impurities when it reaches the burners.

6. There are only two valves to handle and the carbide holders can be emptied and filled without disturbing the lights or admitting any air.

7. The pressure is constant and can be set at any pressure desired.

8. The workmanship is of the very best and every generator is guaranteed against any imperfect work or material for one year.

The following interesting table shows the relative cost of acetylene gas, electricity, ordinary gas, argand gas burners and incandescent gas burners, the comparison being based on an equal number of candle power for each kind of light. The prices for gas and current are those prevailing in this city.

Light.	Cost, per 1,000 ft.	C. P. hours.	C. P. hours for $1.00.	Cost of 1,000 C. P. hours.	Equal to city gas 1,000 ft. at	Saving, favor of acetylene gas.
City gas,* cu. ft..	$1.25	3,200	2,500	$0.39	$1.25	69%
Electricity, Watts	.25	400	1,600	.62	2.00	70%
Acetylene,* cu. ft.	7.50	50,000	6,700	.15	.48	..

*Open flame.

As will be seen by the above table the figures are very much in favor of acetylene, which as an illuminant is the most perfect artificial light known, rivaling the sun itself in brightness. Buildings piped for ordinary gas need not have the same changed for acetylene, the addition of acetylene burners being the only change needed. Acetylene, on account of its clear, white light, is best adapted for showing tints and colors of all classes of goods, and is, therefore, very valuable for merchants in dry goods, jewelry, art stores and galleries, and for social entertainments, libraries, yachts, work boats, steamships, etc. Search lights or reflectors will be furnished if desired, and are of great value for mining and all kinds of night work. For further information, we advise those interested to write to Mr. L. J. Wing, 109 Liberty St., New York City. Mr. Wing is also well-known as the manufacturer of the Wing disc fan, high speed steam engines and marine and stationary gas and gasolene engines.

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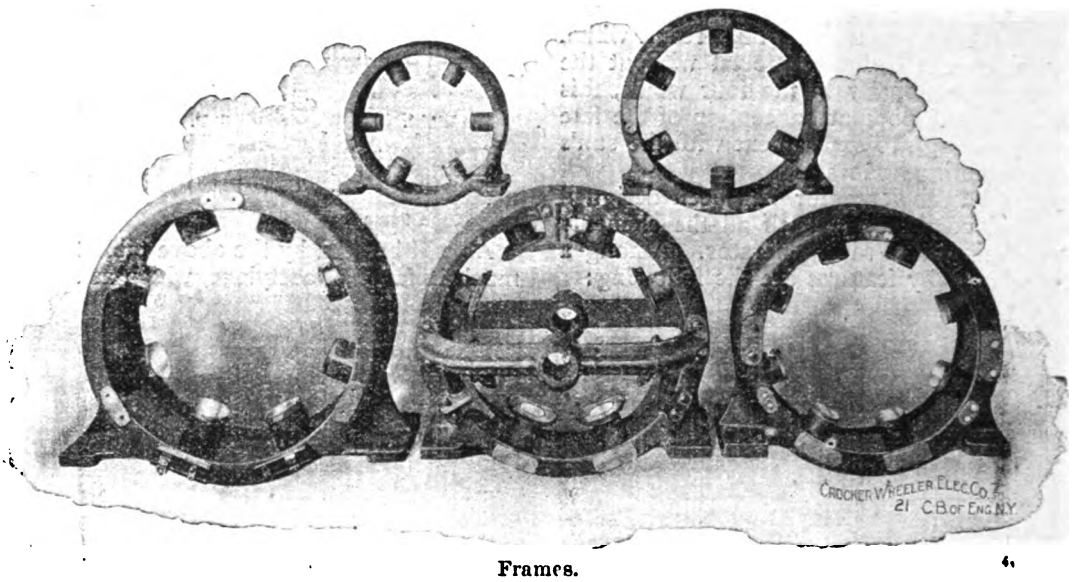
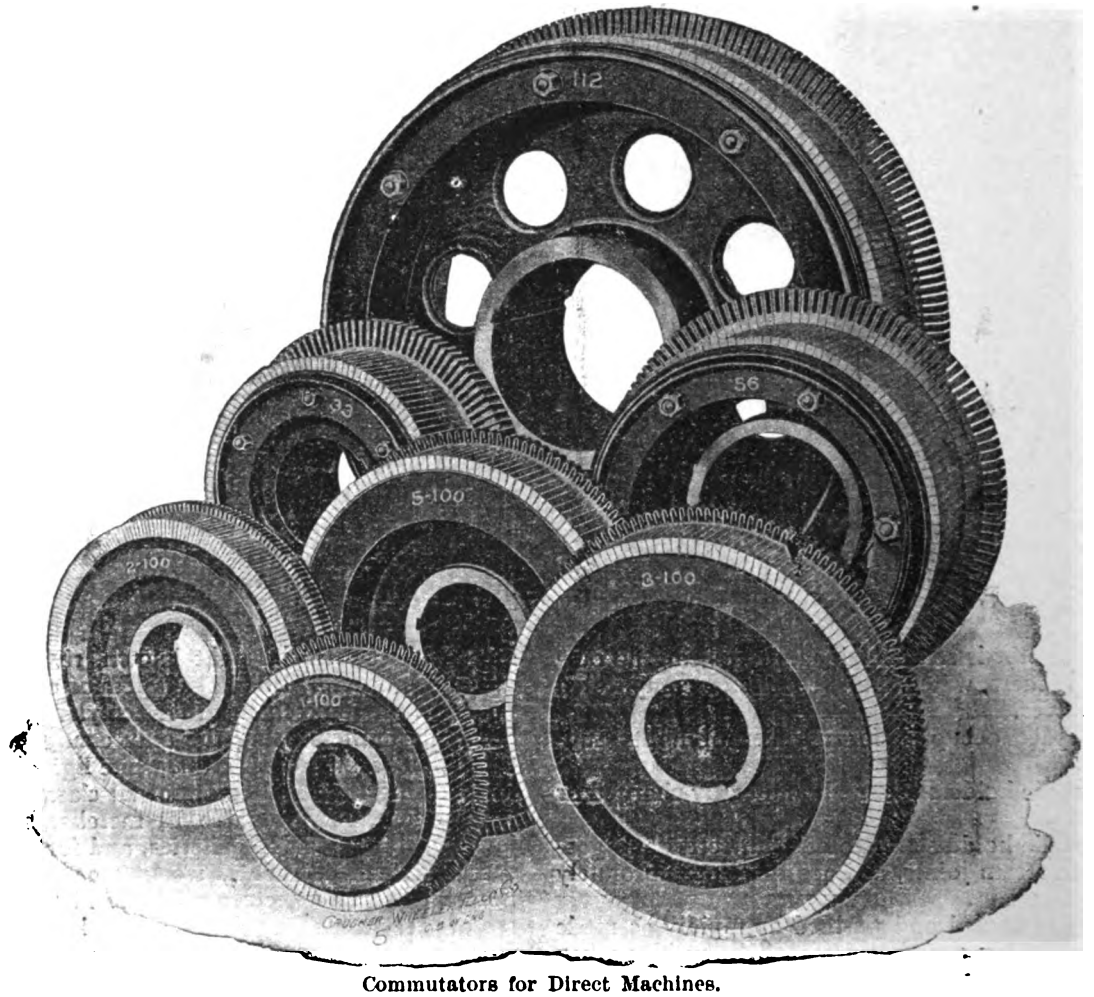
MAGNETISM.

SATURATION AND COMMUTATION.

Cast iron, mitis metal, steel and wrought iron have been used extensively in the construction of dynamos and motors for the past ten years. The mooted question from which has sprung a multitude of uncertainties is that of the point of saturation at which it is most economical to magnetize these various metals. The ampere turns required for one inch length of cast iron magnetized up to fifty thousand lines of force per square inch are one hundred and sixty. If the iron contained a few per cent of aluminum the ampere turns reduce to one hundred and twenty-eight at the same point of saturation. For mitis metal about fifteen ampere turns per inch length would be required at this point of saturation, and so on for the other metals in rapidly increasing figures. It seems established by practise and theory and proven by the dollars and cents it costs to think otherwise that cast iron cannot enter the field of dynamo design without causing possible bankruptcy to manufacturers. On the contrary, annealed iron and cast steel are so closely related, their points of saturation so high and the degree of economy with which they can be used so great that no question



Frames.



Commutators for Direct Machines.

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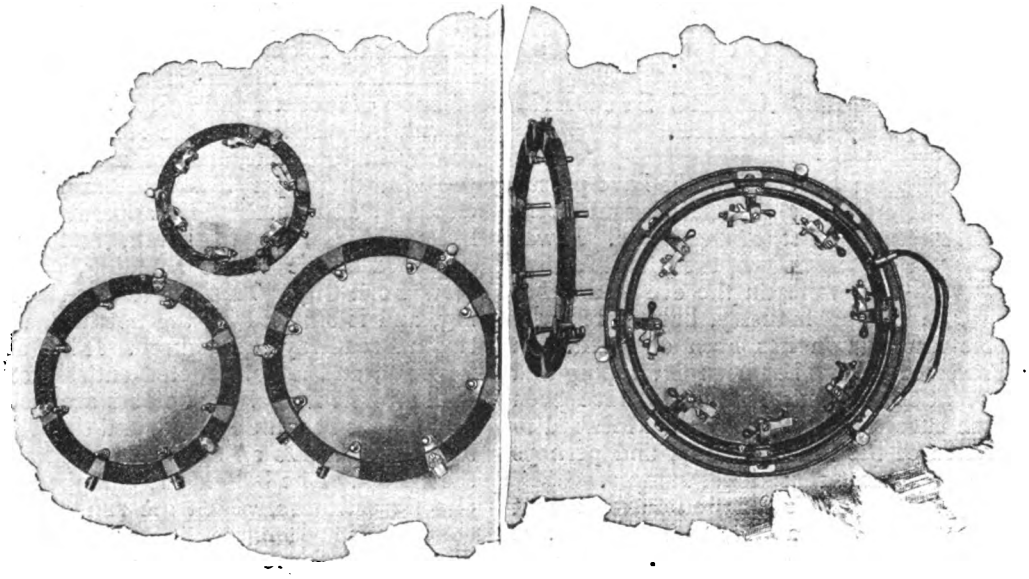
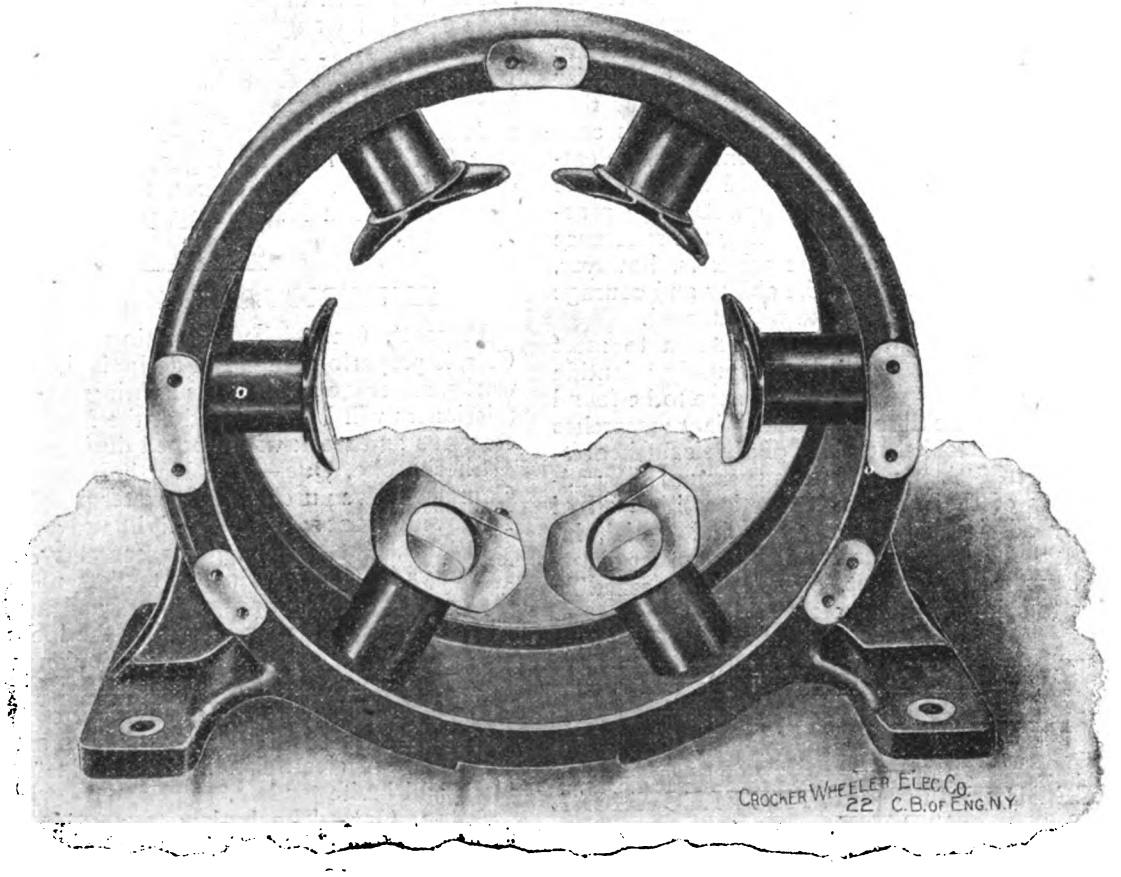
ever arises as to the direct benefits derived from their use. The point of saturation for cast steel is about eighty thousand lines of force per square inch. For wrought iron generally one hundred thousand. The ampere turns required for inch length of cast steel at eighty thousand lines of force per square inch are thirty-four. At one hundred thousand lines of force per square inch the ampere turns required for inch length are one hundred, whereas for wrought iron at this point of saturation they are only ninety-one. It is evident that cast iron at eighty thousand lines of force per square inch is much cheaper to use than wrought iron at one hundred thousand. Consequently we may regard that question as settled, and in looking over the various types of machines, particularly those illustrated, realize that mild steel frames are particularly desirable. The use of removable pole pieces of cast iron means a great saving in weight and cost of construction which manufacturers would do well to take advantage of in every case. The commutators built up in different sizes have been brought to a point of great mechanical perfection. They are electrically perfect as well, each segment carefully calculated as to its carrying capacity and surface coming in contact with the brush. In fact, commutators are built up and held in stock ready for all kinds of winding and any variety of design that may present itself. The failure in many motors and generators has been found largely in the design of the commutator and brush. To properly proportion these from three to five times the cross section of metal should be allowed at the rubbing surface of the brush and segment as is ordinarily considered sufficient for that number of amperes. One million circular mils per thousand amperes



Brush Riggings.



Frame, Showing Method of Fastening on Pole Shoes.

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is a good foundation to work upon. Starting with this practical assumption it is possible to design both commutator and brush so as to eliminate heat and subsequent deterioration at both commutator and brush. Careful attention to this point is the only means by which a smoothly operating and efficient piece of machinery can be produced.

ELECTRIC LIGHTING.

A LETTER FROM A HEIDELBERG STUDENT ON THE NERNST LIGHT.

To the Editor of Science: Several months have passed since the report of the discovery of a new incandescent electric light by Professor Nernst, of Göttingen. It was rumored that a Berlin firm had bought the patent for five million marks, and that we were on the eve of another revolution in the illuminating industry, but till recently very little reliable information has been obtained. In the meantime Professor Nernst has been developing and perfecting his invention, and his researches have been crowned with such success that we may look forward to the early appearance of the finished lamp, and perhaps the confirmation of the most sensational rumors.

The astonishing progress in illumination during recent years has been characterized by a great race between gas and electricity. Scarcely had the incandescent light secured a firm hold in the practical world when Auer von Welsbach made his famous improvement on the gas light, and the possibility of the use of acetylene became apparent, so that many believed that electricity would after all have to yield the supremacy to gas. Nernst now reclaims the palm for electricity, for he expects that the cost for his light for a whole evening will be no more than that of the Edison for an hour.

The Nernst light requires neither vacuum nor tender filaments. The essential point of the invention is that when substances like magnesia (magnesium oxide) and clay are heated above 3,000 degrees Celsius (6,000° Fahr.—far above the melting point of platinum) a very weak current is sufficient to keep them in an intensely luminous condition. Either direct or alternating currents may be employed, and the magnesia is little injured by use. The only difficulty that remains to be surmounted is a practical and inexpensive appliance for heating the substance to the necessary temperature. The work is, however, progressing and those who know the ability and courage of the inventor are confident that he will succeed.

Professor Walter Nernst, though unknown to most people, is a scholar of high rank in the purely scientific world, and his works or their translations are to be found in almost every scientific library. His brilliant researches won him the newly established chair of physical (theoretical) chemistry at Göttingen, and he is surrounded by advanced students of the most varied nationalities, all of whom greatly admire his fertile mind and genial, inspiring manner. His new invention is but another example of the benefit that patient, conscientious scientific study is sure to bring to the whole world.

H. C. COOPER.

Heidelberg.

BUSINESS NEWS.

AN OFFICE BUILDING FOR THE ELECTRICAL TRADE.

The advantages and conveniences secured by having offices situated in the immediate vicinity of the electrical and kindred trades is becoming more and more apparent to the manufacturers of electrical and mechanical apparatus, desirous of centrally located headquarters. The tendency among the manufacturers of machinery, etc., appears to be growing more and more in favor of well-appointed suites of offices in preference to the formerly universal practice of large stores containing the various types of machinery, etc. While the latter practice is, of course, looked upon with a great deal of favor among those manufacturers having their works in the Metropolitan district, still it does not recommend itself to the out-of-town manufacturers who are put to a heavy expense in fitting up large stores, this expense being hardly commensurate with the advantages entailed thereby. The erection of modern and up-to-date office structures in the downtown district and the steadily increasing electrical colony in the same, has, to a large degree, solved the problem of proper headquarters for manufacturers of electrical and mechanical apparatus, etc. One of the latest arrivals, so to speak, and probably the best equipped is the White Building, 95-97 Liberty street, New York City. This is a twelve-story fire-proof building, and is situated on the north side of the street, between Broadway and Church. It has an imposing granite front, and is constructed entirely of brick and steel, with an iron frame. The floors are marble, entirely fireproof, halls beautifully tiled, and the whole interior of the building presents an agreeable and harmonious sight to the visitor. The building is equipped with two Sprague electric elevators, which are run day and night for the convenience of tenants. Tenants can have rooms on any floor, either single or en suite. All rooms have plenty of daylight besides being equipped with electric lights, the power for which is generated by a plant in the basement of the building. This plant consists of two 50 K. W. and one 25 K. W. Eddy dynamos direct connected to Russell engines, and was installed by the Russell Engine Company. The wiring was installed by the Conduit Wiring Company, of this city, and was done according to the latest and best specifications. Among a few of the tenants having offices in this magnificent building are the Fostoria Electric Company, Locomotive Publishing Company, James H. Lancaster, Sterling Boiler Company, Brooks & Co., Albert A. Cary, Consulting Engineer. We would advise those of our readers seeking offices in a desirable location and up-to-date building to pay a visit to the White Building and examine its many excellent features. For offices, terms, etc., apply to the agent, Mr. John N. Golding, 9 Pine St., and 543 Fifth ave., City.

ELECTRIC LIGHTING IN CANADA.

Prescott, Ont.—The consulting engineer, Mr. John Galt, is preparing plans and designing a system of waterworks, sewerage and electric lighting for this town. Commissioners will be appointed at the forthcoming January elections and work will proceed during the year 1899.

Sherbrooke, Que.—The North Hatley Electric Light Company have purchased the water power on the Magog River and propose to supply light and power to this city.

Ottawa, Ont.—L. K. Jones, secretary, Department of Railways and Canals, invites tenders up to the 21st for the construction of a power house and the installation of electrical apparatus for operating the locks, bridges and other structures, and lighting the Soulanges Canal.

Halifax, N. S.—A special committee has been obtaining information as to the advisability of the city undertaking its own street lighting, and, as a result, the city engineer and electrician have been instructed to make plans and invite tenders.

Acton, Ont.—The by-law to provide $6,000 for the purchase of an electric light plant has received the sanction of the ratepayers. Arrangements will be made for the installation of the plant.

Pembroke, Ont.—The report of Mr. R. J. Parke, of Toronto, on the cost of installing a municipal electric light plant, will be presented in a few days.

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Thorold, Ont.—The Electric Light Committee has recommended the extension of the electric light plant as far as possible under the present conditions.

Nelson, B. C.—The judge has quashed the by-law which authorized the Council to borrow money to purchase the electric light plant from a private company.

Brampton, Ont.—The agreement between the Hutton Electric Light Company and the corporation for the lighting of the streets has been signed by the Mayor.

Hull, Que.—The report of the Electric Light Committee was last week referred back by Council for more detailed information as to the cost of installing a plant.

Fort William, Ont.—The appointment of superintendent of electric light plant has been given to Mr. W. H. Smith, of Goderich.

Thorold, Ont.—The tender of the Royal Electric Company for addition to electric light plant has been recommended for acceptance.

Moncton, N. B.—The town is considering the question of making some extensive changes to its electric light plant.

Mitchell, Ont.—The by-law to raise $5,000 by debentures for improving the electric plant was defeated by the ratepayers last week.

Lake Megantic, Ont.—The Electric Light Company have purchased property on which to erect their power house.

J. ALCIDE CHAUSSE.

TOTAL ELECTRICAL EXPORTS FOR WEEK ENDING DEC. 13, 1898, $33,855.00.

New York, N. Y. Dec. 13, 1898. The following exports of electrical material are from the port of New York for the week ending this date:

Argentine Republic—200 packages electrical material, $8,447. 89 packages electrical machinery, $9,203.

British West Indies—63 packages electrical material, $3,135.

British Possessions in Africa—16 cases electrical material, $275.

Brazil—1 case electrical material, $24.

British East Indies—5 cases electrical machinery, $183.

Bremen—8 packages electrical material, $1,791.

Cuba—29 packages electrical material, $641.

Ecuador—1 package electrical material, $12.

Hayti—2 cases electrical material, $207.

Hamburg—62 packages electrical material, $3,089.

London—31 packages electrical machinery, $4,504.

Odessa—4 cases electrical material, $110.

Porto Rico—26 packages electrical material, $1,213.

St. Petersburg—4 cases electrical machinery, $983.

Venezuela—1 case electrical material, $38.

NEW INCORPORATIONS.

Louisville, Ky.—The Carter-Hays Electric Company, incorporated by E. W. Hays, Hugh Hays and L. D. Carter, to manufacture and repair electric appliances and construct electric plants. Capital $5,000.

New Orleans, La.—The Merchants' Electric Light and Power Company, organized with M. Ber, president, Joseph Simon, vice-president, E. W. Goldschmidt, secretary-treasurer and manager; for the purpose of erecting a plant to supply electric light and power. Capital stock $300,000.

Millbrook, N. Y.—Millbrook Gas and Electric Company has been incorporated with a capital stock of $15,000.

Jersey City, N. J.—Dennison Motor Carriage Company, incorporated by Geo. L. Record, Ernest Merrick and J. F. Dennison, to manufacture engines and electrical and other motors. Capital stock $100,000.

Richmond, Ky.—The Richmond Electric Light Company has been organized by Frank Adair and others.

Spartansburg, S. C.—Julius L. Carson and others are forming a company for the purpose of building a plant to furnish electric lights and power.

Adairsville, Ga.—Joe. P. Bowdoin will construct a telephone system.

Crescent City, Fla.—The Fruitland Peninsula Telephone Co., incorporated.

Petersburg, Va.—The Long Distance Telephone Co., has received franchise for telephone system.

New York, N. Y.—The United States Automatic Telephone Co., has been incorporated by Elias E. Ries, Martin Lowenstein, Henry A. J. Milhens, Israel Steinhart, and Henry J. Furlong; to manufacture and deal in telephonic and electrical apparatus. Capital stock $1,000,000.

Ewing, Ky.—Flemingsburg and Myers Station Telephone Co., has been incorporated by I. B. Sherwood, W. R. Darnell, Robert Harper, I. N. Price, and W. J. West; to do a general telephone business. Capital stock $600.

Hinckley, Ill.—Northern Illinois Telephone Co. has been incorporated by F. A. Graves, M. D. Patten, and F. B. Patten. Capital stock $10,000.

Monroe, N. C.—W. S. Lee, J. M. Belk, and R. A. Morrow are organizing a company to establish a telephone system.

Pocomoke City, Md.—The Worcester Telephone Co., directors have decided to extend their line to Pocomoke City, Stockton and other points in the country.

Mexico, Mo.—The Lafayette Telephone Co., incorporated by D. P. Moore and others; to construct and operate telephone. Capital stock $12,500.

Beaver Falls, Pa.—The Pennsylvania Telegraph and Telephone Co., incorporated by H. C. Patterson and others. Capital stock $50,000.

Waco, Tex.—Electrical Construction Co., incorporated by E. Rotan, W. W. Seley and others; to construct, maintain and operate telephone lines. Capital stock $35,000.

New Bedford, Mass.—Automatic Telephone Company has been incorporated by J. W. Macomber and Frederick Tabor. Capital stock $100,000.

Homestead, Pa.—The Homestead Telephone Company has been incorporated by G. Gladden, R. Kennedy, J. Purman, D. H. Carus, A. J. Kuhn, W. S. McConegby, and H. J. O'Donnell to construct and maintain telephone lines. Capital stock $10,000.

Philadelphia, Pa.—The Farmers' and Merchants' Telephone Company has been incorporated by J. P. Darling, John Fischer, W. D. Kissner, T. L. Darling, J. F. Rees, and L. G. Rees to operate a telephone system at Warsaw. Capital stock $5,000.

Benton, Mass.—Youngblood-Stampers Telephone Company, incorporated by R. A. Youngblood, F. H. Stampers and N. H. Youngblood. Capital stock $12,000.

Salt Lake City, Utah.—The Thompson and Moab Telephone Company has been incorporated by Arthur A. Taylor, president; J. C. Taylor, vice-president; Robert James Thompson, treasurer, and Charles Wilson, secretary, to build and operate a telephone line between Thompson and Moab, Utah. Capital stock $1,400.

Lexington, Tenn.—Lexington Telephone Company, incorporated by J. E. Melead, H. E. Cruper and others. Capital stock $200,000.

Berea, Ohio.—The Citizens' Telephone Company has been incorporated by S. B. Rawson, J. A. Duke, F. W. Martin and T. M. Brush, to operate a local telephone system. Capital stock $20,000.

Columbia, Mo.—Columbia Telephone Company has been incorporated by James A. Hudson and others. Capital stock $5,000.

Shelton, Conn.—The Russell-Tomlinson Electric Company has been incorporated by G. G. Milne, C. B. Barker, W. W. Tomlinson and W. E. Russell to manufacture, buy, sell and deal in electrical goods and wares. Capital stock $20,000.

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STREET RAILWAY NEWS.

Chattanooga, Tenn.—The Chattanooga Electric Railway Company filed mortgages with the County Register to the amount of $625,000 in favor of the Maryland Trust Company.

Bloomfield, Mich.—The Bloomfield and Orchard Lake Electric Railroad has been incorporated by George L. Hendrie and others with a capital stock of $50,000.

Hartford, Conn.—F. W. Siebert, Edward W. Shedd and C. Siebert will apply to the incoming Legislature for a charter to build an electric railroad in Cromwell.

Pottstown, Pa.—The Montgomery and Chester Electric Railway Company has been incorporated by W. H. Grebe, C. S. Jarvis, G. G. Fitler and others to construct and operate an electric railway from Pottstown to Phoenixville. Capital stock $300,000.

Washington, D. C.—The Columbia Railway Company will change the existing construction of cable road to underground electric system.

Cincinnati, Ohio.—A stock company has been organized to build an electric road from Cincinnati to Lebanon, a distance of 25 miles.

Hartford, Conn.—The Central Railway and Electric Company has been granted permission to extend line.

Pine Bluff, Ark.—The Pine Bluff Electric Light and Street Railway Company, incorporated with Jeff Hicks, president, T. L. Chadbourne, Jr., vice-president, and H. H. Hunn, secretary-treasurer. Capital $300,000.

West Chester, Pa.—George F. P. Wanger is at the head of a company which has just been granted a charter for a proposed electric railway from Pottstown to Phoenixville.

Hamilton, Ohio.—The Hamilton and Eaton Electric Street Railway Company, incorporated with a capital stock of $10,000.

BUSINESS CHANGES.

Chicago, Ill.—The Victor Electric Company increased capital stock from $2,400 to $6,100.

Rockford, Ill.—The Rockford Railway Light and Power Company has certified to increase from $250,000 to $350,000.

Wilmington, Del.—The Wilmington City Electric Company reported to have been purchased by the Pennsylvania Manufacturing Company, of Philadelphia, who will assume control.

NEW YORK ITEMS.

ZIMDARS & HUNT, 127 Fifth avenue, are obliged to keep their factory running day and night in order to keep up with the demand for their electric light and power specialties.

JAMES R. WILEY, the western manager of the Standard Underground Cable Company offices at the Rookery, Chicago, is in town visiting.

GEORGE L. WILEY, the eastern manager of the Standard Underground Cable Company, Telephone Building, reports business as being first-rate and the outlook for the coming year most excellent.

ALBERT A. CARY has opened up an office as consulting mechanical engineer at 95 Liberty street. Mr. Cary intends making a specialty of steam plants, designing, erecting, reconstructing, testing, etc. He has made the waters for steam boilers a special study and is prepared to analyze and purify them. He has no special apparatus or compounds to accomplish the above purpose, but assumes a purely consulting position with all clients having troubles of this kind, and places them in a position to be able to use waters which have been causing trouble. Mr. Cary's writings and discussions are doubtless familiar to many of our readers. After many years of experience with boilers in all parts of the country Mr. Cary has built a large number of furnaces to burn all kinds of fuel with high economy and is, therefore, prepared to help and advise those needing assistance in this direction. He has also been of assistance to lawyers and clients in working up cases involving steam and mechanical appliances. Mr. Cary's methods of working up such cases differ considerably from those usually employed by expert engineers, as he takes charge of all details of the case, thus saving both lawyer and client considerable time and labor.

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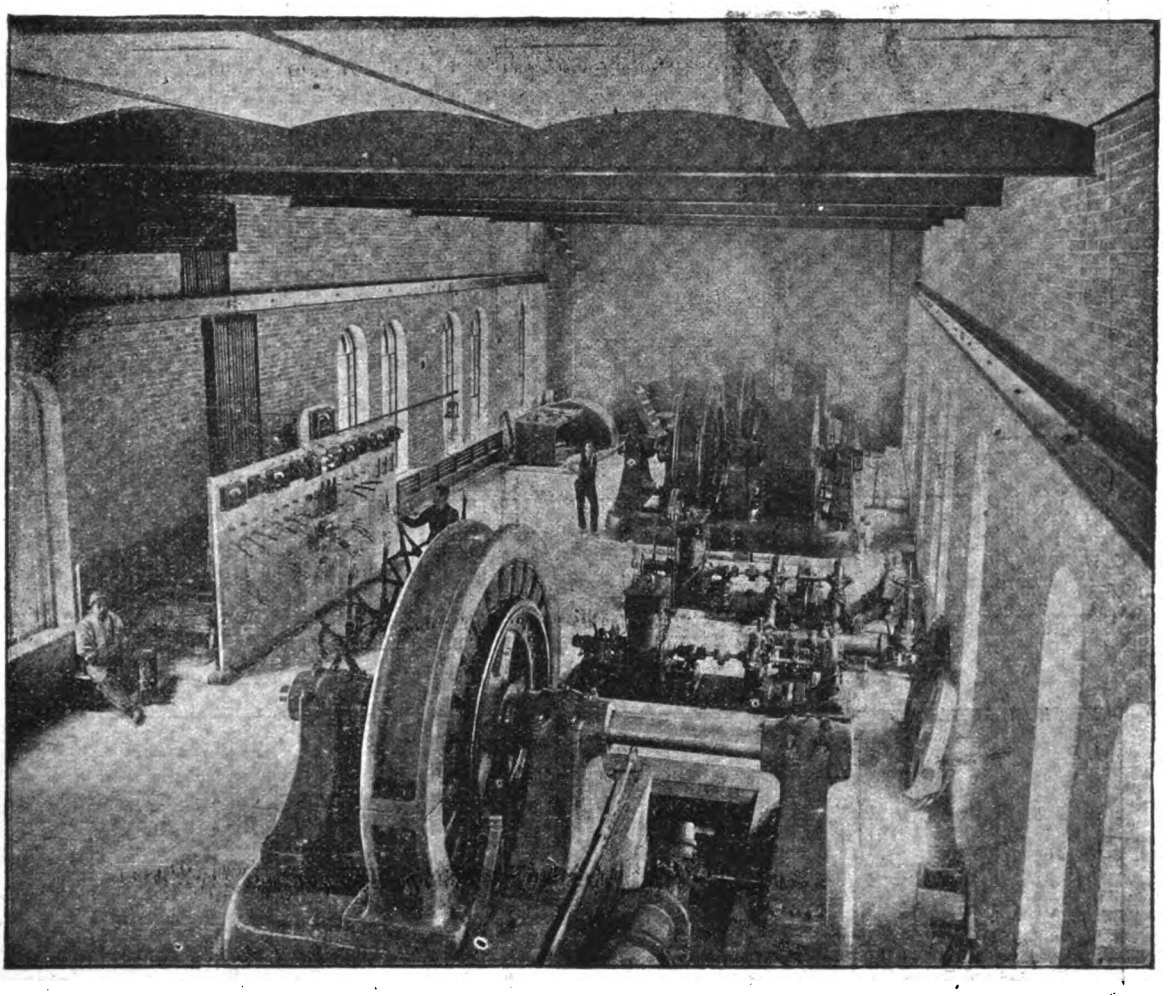
The Electrical Age.

VOL. XXII—NO. 26 NEW YORK, DECEMBER 24, 1898 WHOLE NO. 603

POWER TRANSMISSION.



Interior of the Big Cottonwood Plant.

THE TRANSMISSION OF HIGH AND LOW VOLTAGES.

Enormous electro motive forces are being used at the close of this century for the purpose of efficiently transmitting electrical energy. These pressures, of course, necessitated an improvement in the construction of insulators and various other modifications in the ordinarily accepted system of power transmission. The recent work of Mr. Charles S. Scott, written under the title "High Voltage Power Transmission," cannot fail to impress the reader with the radical changes that have occurred, both as regards pressure and system. The outlines of power transmission prove from a theoretical standpoint that out of 100 per cent. mechanical energy delivered at the generator pulley, only 73 per cent. is obtained at the distant motor end. This means an allowance of 10 per cent. loss in the generator, 10 per cent. loss in the line and another 10 per cent. at the receiving end at the motor. The three governing factors are pressure, distance and size of copper conductors. Many modifications can be made of the relationship existing between these three factors. A high electro motive force is not always desirable unless circumstances allow of a line construction that makes safety self-evident. The first attempts at power transmission since the preliminary experiment of Marcel Deprez have been eminently successful. But since that time the voltage has risen by leaps and bounds. Although the three factors previously mentioned exercise a considerable influence over the output at the end of the line, it must not be forgotten that the frequency is of equal importance from a theoretical, as well as a practical, standpoint. Therefore, like the three musketeers of old who were made famous by a fourth, the pressure, distance, size of conductors and frequency are all important. Where water power is available or other natural forces can be utilized the transmission of power does not always involve the generation of high potentials. It frequently happens that the electrical side of the question becomes

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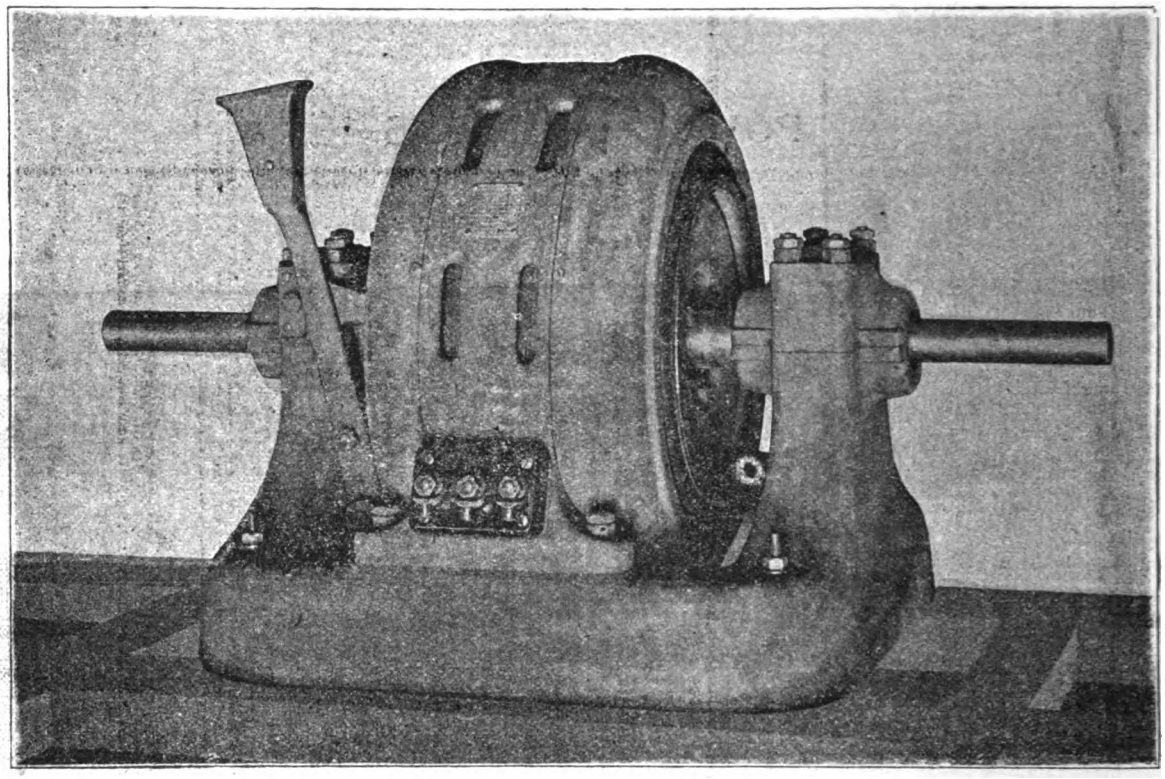
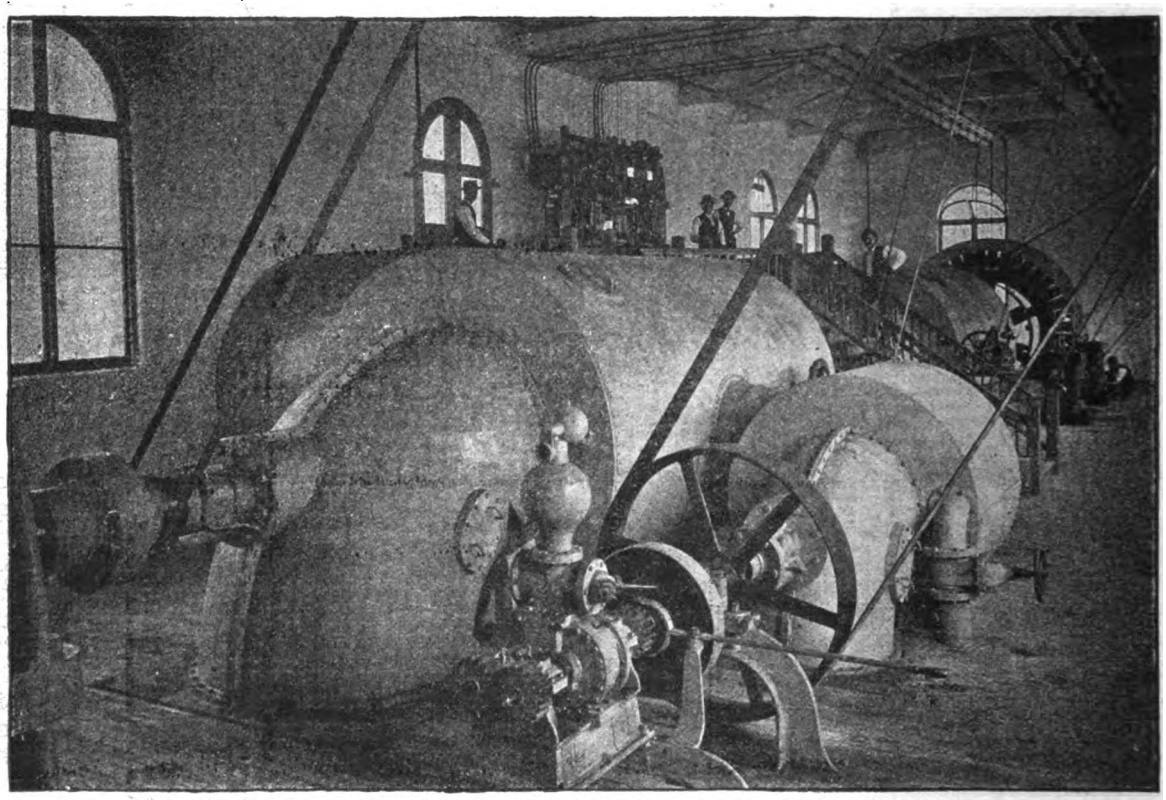
insignificant in comparison with the mechanical. Possibly turbines cannot be installed or lines cannot be erected and inspected on account of the wilderness through which they pass; then again, climatic changes, storms, snow and ice may entirely remove the possibility of keeping the plant in good working operation. Science may be helpless in the face of such discouragements, but provided conditions are propitious high and low-tension and transmission power plants are more than successful in the great majority of cases. The illustrations show cases where installations have been made with considerable success. Of course, the nature of a plant



Suspension of Motor in Columbia Mills, S. C.



Turbines at Pelzer, S. C.

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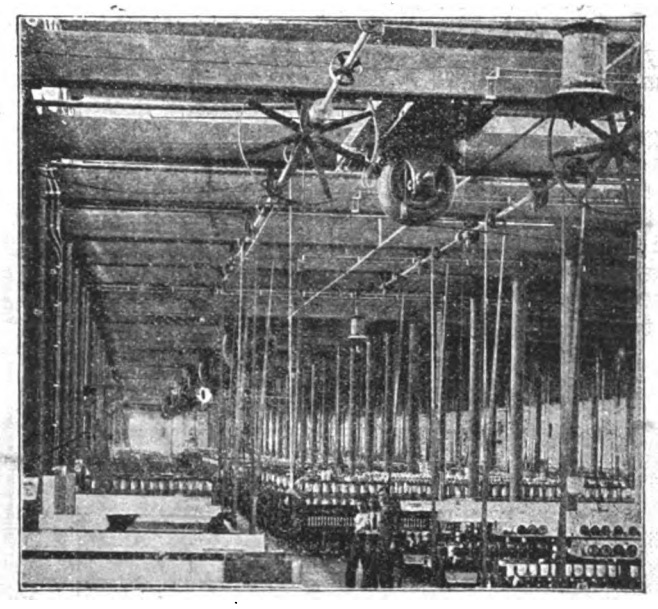
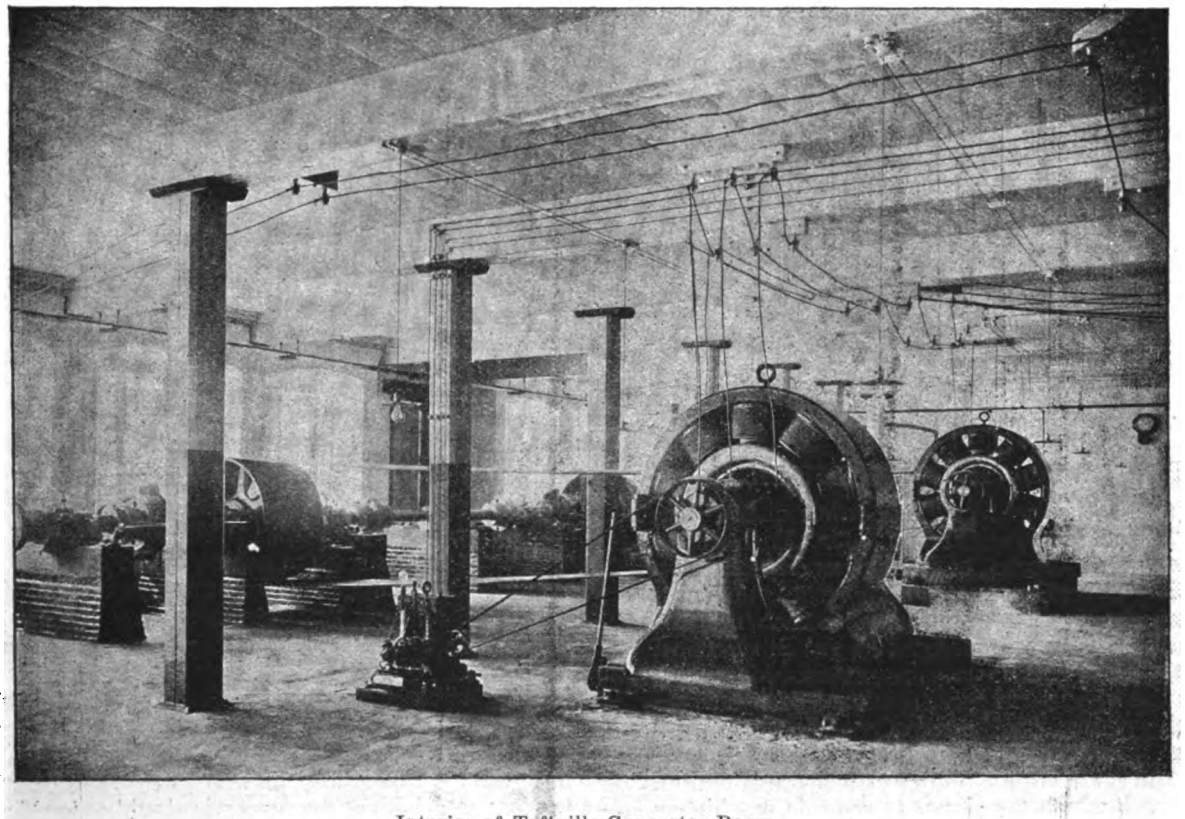
changes considerably on account of the pressure used, as well as the phase and frequency. In Mr. Scott's tests he discovered that rubber-covered wire decreased the loss considerably, probably on account of



Spinning Room, Columbia Mills, S. C.

this superior insulation. He also noted that after a rain, although the insulators were wet, a pressure of from 45,000 to 60,000 volts quickly dried them, and improved



Interior of Taftville Generator Room.

their insulating properties. Tests were made on four lines in multiple, each line composed of two wires supported by twenty-six insulators. These insulators ex-

pressed every variety of design in glass and porcelain. They were exposed to a pressure of one hundred thousand volts, falling to a minimum of 70,000 for six weeks. Although the lines were exposed to heavy rain storms a steady pressure of forty-eight thousand volts was sustained. The results in all these tests were very favorable and bring about the conclusion that, although low voltage power transmission has always been assumed to be a success, as far as insulation is concerned, it is not superior to high tension transmission in this respect, even with

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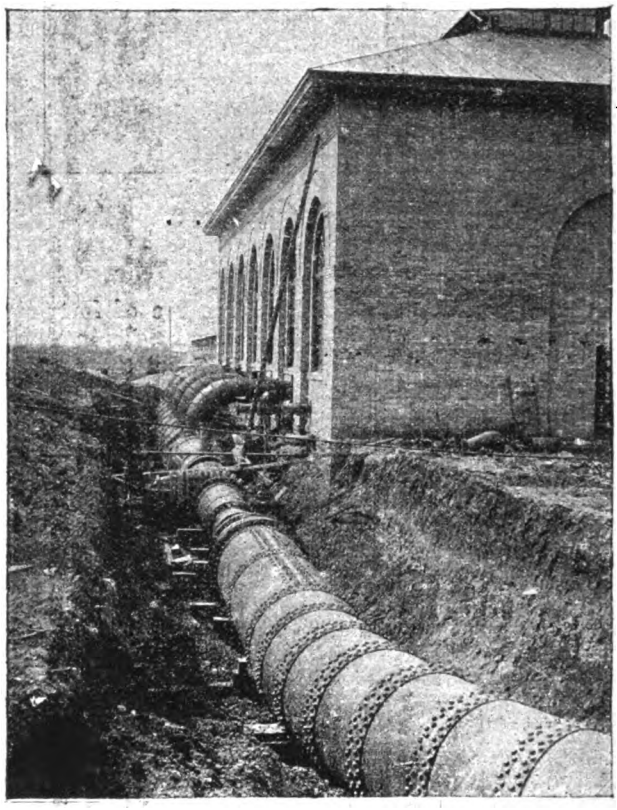
enormous pressures, as quoted above. The improvement in transformers, which includes the use of oil for insulation, coils possessing large surface for radiation, the windings divided into a number of sections and a close regulation, have added great stimulus to the growth of power transmission plants. Manufacturers will guarantee high potential transformers with a range of from one hundred to forty thousand volts and more, if necessary. Power transmission by means of a continuous current is a rather more complex problem, due to the lack of a simple transforming device. Two and three phase generators and motors have so altered the situation that prejudice has absolutely ceased as regards the commercial success of their application. The final triumph has been the supplying of street railways with electric power, taken from a distant waterfall, and strange as it may seem, power is now sold as any other staple article, having a definite market value. With the new century there is still more to be expected in this, as well as other kindred fields.



Exterior of Pioneer Plant, Showing Pipe Line.

ELECTRICAL POWER TRANSMISSION.

Replying to a rather over-cautious article in the "Engineer" on "Electrical Transmission," Mr. Hart, of the De Laval Separator Works, of Poughkeepsie, tells how he had a rapidly extending works to deal with, in which a number of lay shafts, extending in length each 150 feet and 20 feet apart. He was obliged to put in electrical transmission, as the work became too great for his power, and this was done by laying down a boiler and two dynamos, one being driven by the spare engine. One shaft after another was thrown upon the new system, and finally, with the same engine and electrical transmission, much more work was being done, as regards machinery driven, than was formerly the case, and several motors were 400 feet away from the engine. It was found very easy to add one motor after another. Moreover, the old system of shafts was still preserved. The difference was merely in the driving of the many parallel shafts on which the machines may be said to have been grouped. Another letter comes from Wakefield, where Messrs. Green & Son's works have been changed during the past two years to electrical driving. The writer, however, is so hopelessly involved and mixed in style and figures, that it is impossible to pick out anything from the letter.

TELEPHONIC.

TELEPHONE AND TELEGRAPH ON ONE WIRE.

The first telephone test of the new copper wires of the Baltimore & Ohio, between Pittsburg and Baltimore, took place on November 21st, says the "Telegraph Age." It was gratifying in its result and entirely successful in its working, and the use of the wires for simultaneous telegraphing and telephoning will, according to the original purpose, be made a permanent feature of the many Baltimore & Ohio improved facilities for transacting business. The complete success of the first trial was a gratifying surprise. The voice sound from distant points was as distinct as that of the ordinary local telephone at short distances. The test was made over the wires during the time that messages were passing over them between Pittsburg and Baltimore, and Baltimore and Newark.

The tests were in charge of I. S. Hare, chief operator at Pittsburg; Charles Selden, superintendent of telegraph and E. J. Little, chief operator at Baltimore, Md. As these officials are telephone as well as telegraph experts, the success which they announce is doubly significant.

The test was made over the new wire recently strung between Baltimore and Newark, Ohio, via Pittsburg, and the one from Baltimore to Pittsburg. These wires are used for telegraphing purposes, the former being duplexed.

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THE AGE OF AUTOMATIC DEVICES.

The principles that have been crystallized in science for industrial purposes are comparatively few, although the different phases of invention and mechanical combinations indicate the use of more than one in many important inventions. In the practice of medicine the drugs used do not amount to more than a dozen, but their proper application, their judicious use, are quite sufficient to stop the inroads of disease and effect many important cures. In the world of scientific activity, in steam, electricity, chemistry, etc., there are not many more principles used than the aforesaid dozen. In fact, in all branches of science that lean towards the field of industry and in which prominent names appear connected with the origination and development of important devices, it is surprising to realize how great an influence a fundamental idea will exercise over that department of science, the value that attaches itself to that particular branch and the suddenness with which it springs into view. Perhaps there is no more interesting stage of development to be noted in the engineering world than that which relates to the use of automatic devices. We are fast approaching an age of push buttons. The push button elevator has appeared, the push button switch, and in the purely mechanical field two of the most important inventions have been the familiar typewriter, with its keyboard of push buttons, and the great linotype machine, similarly equipped. A device has been perfected such that the mere pressure of a button immediately and effectively stops the largest of steam engines. All of this seems to be but a magnificent eulogy of nature. We see in her, by the means she takes to create nerve systems in tissues, the centralization of the most important nerves in so-called ganglions and their ultimate co-ordination in the brain of whatever creature or species exercising these functions, only a positive illustration of what we have just discovered and have not ceased to regard as wonderful. The button needs the touch of man to set into operation the forces under its control. The brain itself is composed of small areas to which impressions pass and from which they are sent—the sensory or motor nerves, the one carrying the impression, the other sending or causing to operate the actuating force. Our nervous centers effected by natural influences, internal and external, represent in many respects the points from which radiate lines controlling circuits operating machinery, running multitudes of electric lights. Push buttons will play a great part in the future history of civilization, and they are always an indication of the completeness and perfect automaticity of the mechanism they control. This tendency of the human race to reduce work to a minimum by employing keys or buttons was first exemplified in the invention of the spinnet, the old fashioned piano of the sixteenth century. The idea seemed to be fascinating, and an immense amount of labor has been done since then by mere finger touches, by the simple pressing of a button. One of the great characteristics of electrical inventions is the ease with which they can be controlled in this manner. In fact, it is always with pride that the daily newspaper reporter refers to the way in which the President of the United States opened the World's Fair or the Electrical Show or the Trans-Mississippi Exposition, etc., by a touch of his finger. That has always been considered a great triumph, and we merely refer to it because it stamps the close of this century most emphatically as a period from which we look forward with absolute certainty to the universal use of automatic machinery. Not necessarily electrical nor even mechanical, but combination types, through the medium of which labor is so facilitated and work so readily performed that little that is desirable will be left for the imagination of mankind to deal with in the line of labor saving devices. We have not as yet reached our limit, and there is no reason why we should not presume to believe, as the past has shown, that new principles will be discovered—possibly new forces—and in consequence of these, inventions of so astounding and fascinating a nature that we dare not anticipate them. The world at present is ripe for such things. To-day we see through opaque objects, we telegraph and transmit power without wires, we use the tides and waves of the ocean and the waterfalls of the land, and in the majority of cases much of our success has been due to the employment of machinery which in a certain sense governs and controls its own action and operates with such smoothness and efficiency that we cannot help but say "It is finished."

Brussels has a 5-story telephone exchange building, costing $193,000, and with commutators for 15,000 subscribers.—Ex.

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ELECTRIC MINING.

ELECTRIC MINING APPLIANCES.

In the illustrations are shown some few outfits and appliances used in connection with electric mining. The Marvin electric drill, shown with full connection, including the generator, shows the system of connections by which the drill performs its function. A series of impulses pass in regular succession without the medium of either switch or commutator. By this means the drill is immediately made superior to those that are troubled with failing parts. A percussion drill, to be efficient, must be very carefully designed and constructed. The prejudice that once existed against them has practically died out, and the drill, as shown, has proven a complete practical success. The rotation of the armature sends an impulse of current first into one coil and then into the other. By being automatic in this wise and excluding catches, commutators, sliding contacts, etc., in the drill proper, the highest pitch of excellence is attained and a simplicity that leaves no room for criticism. The attractive power of a solenoid which depends upon its ampere turns gives to this device the power it requires for operation. The details of this have been carefully worked out so that the modern electric percussion drill, stripped of all elaboration, is unquestionably an able competitor of the best thus far constructed.

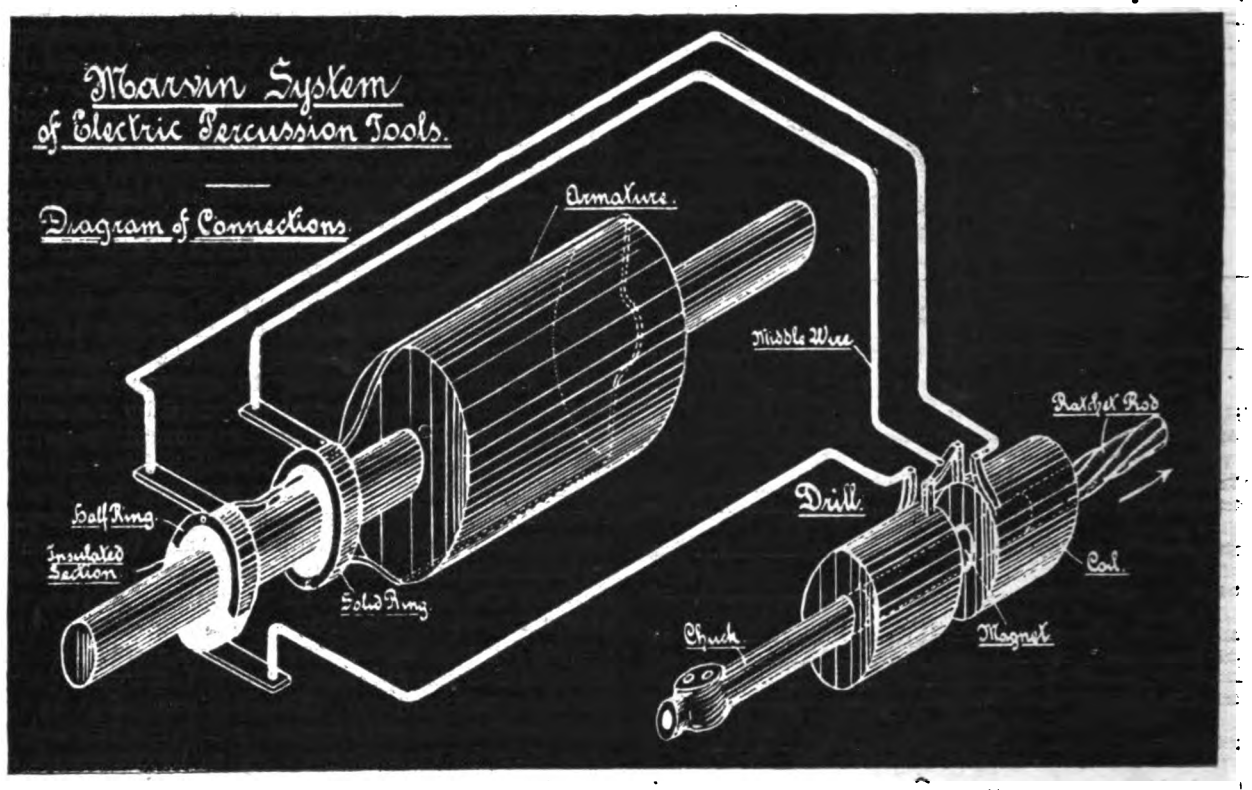
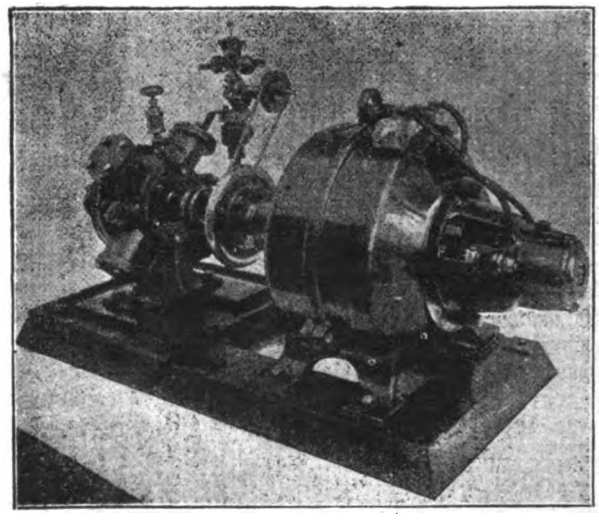


Diagram of Marvin Generator and Percussion Drill.

ELECTRIC LIGHT AND POWER.

PORTABLE ELECTRIC LIGHT PLANTS.

Those remembering the days of Barnum's circus will recollect the magnificent brilliancy of the calcium light. To-day this is more than outrivaled by the sunlight glory of the electric arc, produced by a plant in which boiler, engine and dynamo are trundled along on wheels with less inconvenience than that associated with the lime light of bygone days. The illustrations place before the



An Up-To-Date Direct Connected Electric Light Plant.

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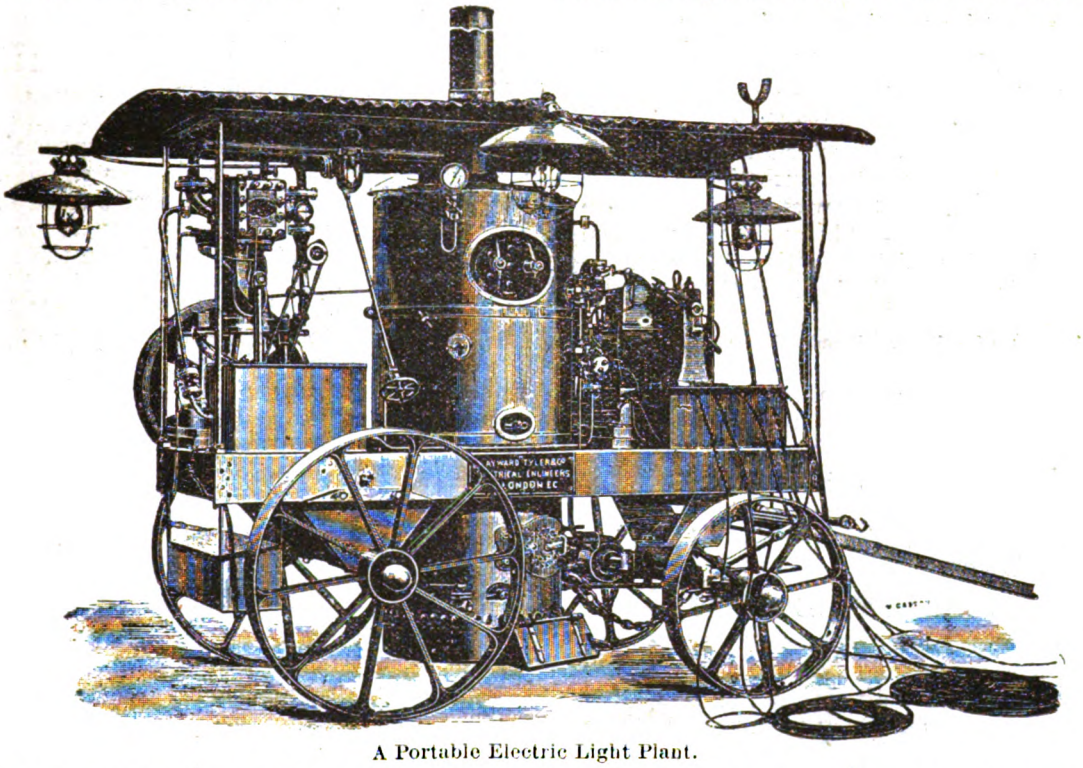
reader's eye two types of compact electric light equipments. One of them to be drawn by horses, the other to be operated from any convenient steam supply; if necessary, one similar to that on wheels. There are many occasions in city life where accidents of various descriptions, public affairs of a civic nature and other events of importance call for sufficient illumination, which, in many cases, is noticeable by its absence. For such circumstances as these a portable electric light plant fills a position of great consequence. From a five to a ten horsepower plant installed, as shown, at least ten arc lamps could be operated, or five focussing lamps of five thousand candle power a piece. The system would be more convenient if the boiler was heated by means of oil, and the dynamo and engine were directly connected, as shown in the more modern plant composed of a Brotherhood engine and Lundell dynamo. The use of these installations have been suggested for military purposes during a land engagement, for instance, or to assist in the erection of temporary telegraph lines, the building of pontoon bridges and other forms of military engineering. Buffalo Bill uses portable electric light plants for the illumination of his famous Wild West Show.



A Portable Electric Light Plant.

MISCELLANEOUS SCIENCE.

STRAY CURRENTS.

THE TRANS-AFRICAN TELEGRAPH.

It is reported that an expedition in charge of R. D. Mohun, bound either for Zanzibar or Mombasa, has already left Bombay. Under an agreement with the Kongo Free State, this party will construct a telegraph line from Lake Tanganyika to Stanley Falls, on the Upper Congo, the work being carried out under the commissions of the state. W. Cavendish, the well-known explorer, is already carrying the line northward through the extreme northern territory of the Chartered company, and it is confidently expected that he will form a connection with the Mohun line within the next two years. By that time the Tanganyika line will have reached Stanley Falls, and Cape Town will be in telegraphic communication with chief towns on the Upper Congo, or, in other words, half the length of the line which is to connect Cape Town with Cairo will be complete. On the other hand, advices from Alexandria are that the line is being pushed southward as fast as possible. The Sidar kept up complete communication between the front and Cairo, and now the news comes that the line is being carried towards Fashoda from Khartoum at the rate of four miles a day.—Ex.

AMERICAN ELECTRICAL GOODS ABROAD.

American lamps and other electrical goods are exposed for sale on the Brussels market, and are conceded to be superior to those imported from Germany, France and England, and with proper effort the trade in this line could be greatly increased. Especially in copper wire, insulated wire, large cables and arc lamps, is there an excellent opening.—Ex.

SPREAD OF THE INDEPENDENT ELECTRIC MOTOR PRACTICE.

It is said that a new hardwood flooring factory, now being erected at Cadillac, Mich., will possess the unique characteristic of being destitute of shafting and of having but one driving belt—that one driving the dynamos. There will eight flooring machines and other tools necessary in such a factory, each machine having an independent electric motor.—Ex.

ELECTRICAL CANCELING MACHINE.

An electrical canceling machine is being introduced into the post office at Youngstown, Ohio. The apparatus is run by an electric motor, and is capable of canceling 360 letters per minute. The machine is furnished with changeable type and a self-inking roller, and is fed somewhat after the style of a printing press, although less pains are required in getting the letters in straight. The mail matter is dropped into a trough at the bottom of which is a belt which carries the letters to the printing part of the machine, where the postmark, date and name of the city are printed on the letter. After the letter is marked it is carried by a continuous belt to a trough-like box, where the letters are delivered in the same manner as newspapers from a perfecting press.

GEOGRAPHICAL NOTES.

Thre are two meridians trending from one magnetic pole to the other where the variation is zero. One of these

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meridians crosses the Atlantic ocean in a diagonal direction from the eastern part of South America and thence passes through North Caroline, Ohio and Michigan; it passed through London in the year 1657 and Paris 1669; the other crosses Australia, Western Asia and Eastern Europe.—Ex.

TELEGRAPHY IN CUBA.

The Signal Service Corps has begun the construction of a government telegraph line connecting Santiago with Manzanillo. The construction party comprises thirty-five officers and men and a medical officer. They carry provisions for two months. The wire will be stretched overhead along the road over which the Spanish general, Escario, marched his 3,500 men 170 miles from Manzanillo in ten days to the assistance of General Toral, when the Americans were before Santiago early in July. The line to Gauntanamo is almost finished, and will soon be in use. General Wood has ordered Captain Brady, of the Signal Service Corps, to begin the construction of a line to Holguin and Gibara immediately, in order that the headquarters of the department may be in touch with Colonel Hood's Second Immunes, who are stationed at Gibara, with which place there is now no communication except by coasting vessels.—Ex.

IN THE AZORES.

Prince Albert of Monaco is having an observatory built at the Azores for magnetic observations. The advantages of a station there will be its situation near latitude 40 degrees; artificial causes of perturbation, electri lighting, tramways, etc., will not be present; and the geographical position, intermediate between Europe and America, should furnish useful indications for comparison of the magnetic curves obtained on those continents.—Ex.

The establishment of a large electrical power plant, to be run by gas engines and to utilize the surplus gases from the by-product coke ovens, at Dunbar, Pa., has been proposed, and there is no reason why it could not profitably be done in a district where there is a demand for power. The suggestion is worth serious consideration from coke makers elsewhere. Power, considered as a by-product of the coke oven, may in many cases be an important and profitable one.—Ex.

LIGHTNING IN A MINE SHAFT.

In the "Annales des Mines (volume II., 1897, page 910), E. Fineuse says that at the Abhooz Colliery, near Haveny, on July 1st, 1897, a flash of lightning struck the iron pit-head only 16 meters high, in preference to three neighboring chimneys from 25 to 40 m. Part of the electric current went down the winding shaft, which is tubbed with cast-iron rings and contains the pipes from the underground pumping engine; and at the level of 210 m. it caused an explosion, without serious consequences, in the pumping engine-house, after which it became dispersed in the pump, at a depth of 400 m. The other portion of the current, which remained on the surface, passed along the wires for the electric bells and telephones, breaking and burning these appliances, and also throwing down the underground manager, who was near the mouth of the shaft, as well as four men engaged on the screens.—Ex.

MAGNETISM.

GALVANOMETERS AND MAGNETIC DIP.

Mr. A. P. Trotter, the Cape Government electrician, writing to "Nature" from Cape Town on November 9th, says: "That while the variation of magnetic dip in Europe (from about 71 degrees in Aberdeen to 58 degrees in Rome) probably gives little, if any, trouble to users of compasses and portable horizontal galvanometers with pivoted needles, the dip of about 58 degrees to the south at the Cape is sufficient to disturb seriously such instruments. I have seen several galvanometers which were useless until re-adjusted: these, having been sent out by makers of high reputation, were thought to have received damage on the voyage. I learn that it is a matter of routine in the Post Office to correct all new instruments for dip. Small pocket compasses are not appreciably affected, because the center of gravity of the needle is generally well below the point of support, and prismatic compasses escape, probably, on account of the weight of the card. Instrument makers could easily arrange a small magnetic field in their testing rooms, with a dip to the south of about 60 degrees, in which to adjust instruments intended for the Cape or Australia."

THE MAGNETIC SUSCEPTIBILITY OF IRON.

Except perhaps by experts in electricity, it is not commonly known how the magnetic quality of cast iron is affected by its mixture with certain other metals, and the short article on this subject which appeared in the "Western Electrician," of October 8th, may serve to supply information that is not usually found in the ordinary text-books. Mr. Foree Bain says that when there is manganese in cast iron to the extent of 12 per cent., it cannot be magnetized with the most powerful currents or electro-magnets. The molecular rigidity, magnetic reluctance, magnetic inertia, coercive force or whatever you may choose to call it, of such iron, is too great to be overcome by ampere-turns, and hence the ampere-turn theory would not apply to a core made of iron of this quality any better than it would to a core of brass. Similar results follow, but to a smaller degree, when iron contains carbon, phosphorous, sulphur, etc., to exceed a certain small limit. The slightest trace of antimony will entirely destroy the magnetic qualities of iron which contains it. All iron of commerce contains some of these impurities to some extent. It does not run evenly in the same brand and there are no two brands that contain the same combination. The great variation in the magnetic susceptibility of iron accounts for a correspondingly great variation in the capacity of dynamos and motors of the same type and size. Every constructor of such machines has noticed the wide difference in the speed, voltage, etc., of dynamos of the same type, each having the same number of ampere-turns, but one having from 10 to 25 per cent. greater capacity than the other.—Ex.

PRODUCTS OF THE ELECTRIC FURNACE.

NITRIDE OF CALCIUM.*

A new body, a nitride of calcium, has just been announced by Mr. Henry Moissan, the eminent French chemist. This body is formed by gently heating metallic calcium in an atmosphere of nitrogen, when a combination between the two takes place. At a dark red heat the reaction becomes violent, raising the whole mass to incandescence. Mr. Moissan finds that the yellow color usually associated with metallic calcium is due to a surface coating of this nitride, the pure metal being quite white. The chemical composition of the new body appears to be $N_2 Ca_3$; its specific gravity is 2.63 at 62 deg. Fahr., and its melting point somewhere in the neighborhood of 2,500 deg. Fahr. Its most remarkable property appears to consist in a reaction between the nitride and water, resulting in the production of ammonia quite analogous to the production of acetylene from calcium carbide. Mr. Moissan thinks that this reaction may ulti-

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mately prove of considerable industrial importance, provided that the difficulties of cheaply preparing metallic calcium by means of the electric furnace are successfully surmounted.

*Trade Journal's Review.

ELECTRIC POWER FOR MILLS.

"It is the purpose of this paper to attempt to describe from the actual operation of two plants working under as nearly identical conditions as two manufacturing institution can—the one operated by rope transmission, with heavy head shafts, sheaves, etc., and the other by means of motors distributed throughout the building. In one the actual operation of the steam engine is considered; in the other the current is supplied to the motor from the secondary switchboard or receiving station.

"Many have considered electric transmission in the light of a source of power, and we often hear comparisons on it with regard to power costs which are very misleading. Some have been imprudent enough to assert its economy for power purposes in connection with uneconomical water-power plants, as the means of making such developments commercially available; and several large plants for cotton mills have been developed on this line with such blindness as to their true commercial value from an economical standpoint that room is left for well-founded skepticism of their true value when compared with the many other more economical installations which might have been effected. Electricity's true position for power purposes is that of a transmitter; and, whatever the sourceof power, the point to be considered is its efficiency in connection with that source for transmitting purposes. Having settled that, our investigation then leads to its comparison with other well-known methods of transmission.

"For the purpose of this paper we will take up the investigation, by tabulated data, from the actual every-day operation of the plants. The period during which the conditions as regard the working load were approximately the same was between the 1st of April and the 25th of June, 1897, and we shall designate the two plants as No. 1 and No. 2. No. 1 is a steam-driven mill, having a steam plant geared up with ropes, heavy head gearing and large tapering shafts, as such plants are usually geared up in the best practice of to-day. The steam engine is an 800-horse power Corliss cross-compound, built in 1895, with cylinders twenty and forty by sixty inches stroke, and a rope wheel twenty-four feet pitch diameter, grooved for twenty-six one-and-three quarter-inch ropes, weighing thirty-five tons. This engine is being operated at an exceptionally low cost per horse-power for steam. There was in the mill during the period for which comparison of power is made 11,776 spindles and 720 looms; all the spindles and preparatory machinery were run full, but the looms did not average more than 682 per day. No. 2 is an electric driven mill, which rents its current from a central station and distributes it through a continuous-reading wattmeter to four 150-horse-power inverted motors bolted to the ceiling in convenient locations for economical distribution of the power, and belted to the shafting. The mill has been in operation since the 1st of January, 1897. This mill had in operation during the period named above on an average 12,448 spindles, with preparatory machinery, and an average of 356 looms out of 500 in the mill. The weight of the shafting in the steam mill is approximately 136,000 pounds, and in the electric mill 122,00 pounds. * * * We find that the average in the steam mill is 535.71 horse-power for all purposes (this mill is only partly filled with machinery, and is using not quite two-thirds of its full power).

"From indicator cards taken we find that the power required to drive the shafting and belting on loose pulleys only is 228 horse-power; for the 720 looms and shafting only 349 horse-power, and for the whole mill 595 horse-power. Deducting the friction horse-power from the power required to drive the looms and shafting and dividing this result by the number of looms, we obtain the power required to drive one loom, which is 0.168 horse-power.

"Deducting the power required to drive the looms and shafting from the total power gives us 246 horse-power, which is the power required to drive the spindles and preparatory machinery. This amount divided into the number of spindles gives us sixty spindles per diem and 357 looms, as against the steam-mill machinery for this number of spindles.

"At the time the data given above were obtained, there were in operation in the mill 14,848 spindles, with the necessary preparatory machinery, and 720 looms.

"In the electric mill, owing to the lack of suitable instruments for testing the separate motors, we were unable to find the amount of power expended in friction, and consequently, having only the average power consumed, we can compare the mills by using the data obtained from the steam mill to bring the electric mill to the same basis. From the power chart we observe that on an average 418.2 horse-power per day were used in the electric-driven mill during the period above alluded to, namely, from the 1st of April to the 25th of June. During that period there were in operation on an average 12,448 spindles per diem and 357 looms, as against the steam mill operating 11,776 spindles and 682 looms.

"From the data obtained from the steam-driven mill we have the following distribution of power during the test for the steam-driven mill: Total power, 535; looms and shafting, 340; friction, 226; horse-power speed, 196; looms, 114; and for the electric-driven mill; Total power, 418; looms and shafting, 206; friction, 149; horse-power speed, 208; looms, 60. Hence the difference between 226 horse-power and 149 horse-power, which is seventy-seven horse-power, must be credited to the electric mill in its present condition.

"The following points from the foregoing can be stated as existing under the present conditions: The steam mill is operating under a disadvantage of an underloaded engine; the electric mill is operating under the disadvantage of driving more shafting per motor than it will when the full complement of machinery is installed.

"The steam mill requires more supplies in the shape of oil, sizing for ropes and other necessary incidentals due to the method of transmitting the power. The electric mill has cost nothing for its motors in six months of operation—not even the necessity of putting oil in the bearings, which was simply renewed once in that time as a precaution. The convenience of operating any section of the mill 'ad libitum,' without reference to the other sections, is an advantage which is felt in dollars and cents in plants using the electric transmission.

"The question which arises as to whether a generator directly connected to an economical type of engine to produce the power would consume the difference in the frictional horse-power is one which can only be answered from data from institutions having such plants. It is the author's opinion that this difference of power would not be exceeded, and he hopes subsequently to give more specific data from further experiment from the actual operation of these two plants under better conditions, viz., when both mills are completely filled with machinery and motors and engine run at their full load; also in obtaining the efficiency of direct-connected engines and generators.

"It must be borne in mind that, unlike a machine shop and other manufacturing establishments, where a large

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amount of shafting is required to cover the ground and where intermittent power is used, a cotton mill drives in useful effect 95 per cent. of its shafting and uses actually in continuous operation almost the maximum power at all times."

SMALL ELECTRIC MOTOR USES.

Those who have the management of public electricity supply undertakings know full well the value of the electric motor as a factor in the reduction of the working costs.

But there are other and probably greater effects which the electric motor will produce with its more complete adoption in the near future—the writer refers to the beneficial effects upon the trade and productions of the country, and the hygienic and social effect on the community generally. In the first of these aspects it is possible to foresee the revival once more of a number of small and independent industries, such as existed, but under very different conditions, in former years. The possibilities are already being grasped by the artisan in France, Germany, Switzerland, and the United States. By the aid of the electric motor he begins to find that he can at least hold his own in competing with immense manufacturing concerns and combinations; he has a practically unlimited available power at his own door—which is a great boon to the artisan, and one which offers him an inducement to become his own master.

In a very small and limited degree the gas engine has already accomplished something in this direction, but its many imperfections, its cost, and the fact that it has never been available on the hire system, have kept it more or less in the background. The effect of hiring-out electric motors is thus mutually advantageous, and its natural tendency is to create fresh demands; in fact, the municipality which includes this scheme in its electric light undertaking offers a great inducement to the influx and establishment of new industries within its area.

With a more complete return to a multiplicity of industrial operations, there may also revive some neglected trades. From an hygienic point of view, the electric motor is far and away the best; it is cleanly in its working, gives off no deleterious gases, and displaces the boiler and smoky chimney. One of the ultimate results must also be the raising of the status of the working part of the community. By becoming his own master the artisan gains self-respect, becomes more resourceful, and therefore a more important member of society; and the more intelligent interest which he will display in his business must appreciably affect the general welfare of the country.—Alfred H. Gibbings in Cassier's Magazine for January.

ROENTGEN RAYS.

ROENTGEN RAYS AND COAL.

It was ascertained in the early days of the Roentgen rays that the rays pass without difficulty through the various modifications of carbon, but are stopped by silicates. In this manner we are able to distinguish between real diamonds and paste. Couriot, in "Comtes Rendus," has now observed that radiographs give a fair idea of the purity of a coal. That this should be so, in a certain sense, is not surprising; one might fear, however, that the test would be too delicate to be of any practical value. Experimenting with anthracite coal, lignite, peat, coke, briquettes, etc., Couriot found that the structure of the combustible, the presence of mineral impurities, and also the stratification could easily be recognized by the help of the Roentgen rays. Grains of pyrites are at once seen in coke. It is not necessary that the samples should be cut to regular shapes. Couriot did not take blocks of more than 2 inch, however, which he exposed for about five minutes.—Ex.

CHEMICAL EFFECT OF CATHODE RAYS.

Some experiments on the chemical effect produced by the impact cathode rays, made by Professors Momson and Skinner, are thus reported by London "Nature": "Aluminum is rapidly evaporated from the cathode by an electric discharge in a highly exhausted vacuum tube in which air has been replaced by mercury vapor. The metal is condensed over the walls of the tube in the form of a bright mirror. An iron cathode gives a similar mirror in a mercury vapor discharge tube. When the aluminum coating is dissolved off the wall of the bulb by hydrochloric acid a gelatinous membrane remains, which gives the reactions of silica. When potassium vapor is used the glass opposite the aluminum cathode is roughened. In parts sheltered by screens from the discharge the glass is not attacked. In potassium vapor the aluminum cathode is not evaporated to any marked degree. Opposite the cathode, both in the mercury vapor and potassium vapor bulbs, a dark annular stain of the shape of the cathode is formed. This stain resists the action of strong hot hydrochloric acid, nitric acid, aqua regia, and potash solution. The action of hydrochloric acid removed it, apparently, by dissolving the glass. The tests indicate carbon, but the quantity of the stain is too small to make certain. The stain is also formed on screens of mica, quartz and calcite. Monatomic gases appear to permit the evaporation of aluminum, as Professor Callendar has observed its evaporation in an argon vacuum tube."—Journal of the Franklin Institute.

THE VELOCITY OF X-RAYS.

In the mechanical construction of Roentgen-ray tubes I can record a few advances, the most successful being the adoption of Professor Silvanus P. Thompson's suggestion of using for the anti-cathode a metal of high atomic weight. Osmium and iridium have been used with advantage, and osmium anti-cathode tubes are now a regular article of manufacture. As long ago as June, 1896, X-ray tubes with metallic uranium anti-cathodes were made in my own laboratory, and were found to work better than those with platinum. The difficulty of procuring metallic uranium prevented these experiments from being contiued. Thorium anti-cathodes have also been tried.

Roentgen has drawn fresh attention to a fact very early observed by English experimenters—that of the non-homogeneity of the rays and the dependence of their penetrating power on the degree of vacuum; rays generated in high vacua have more penetrative power than when the vacuum is less high. These facts are familiar to all who have exhausted focus tubes on their own pumps. Roentgen suggests a convenient phraseology; he calls a low-vacuum tube, which does not emit the highly penetrating rays, a "soft" tube, and a tube in which the exhaustion has been pushed to an extreme degree, in which highly penetrating rays predominate, a "hard" tube. Using a "hard" tube, he took a photograph of a double-barrelled rifle, and showed not only the leaden bullets within the steel barrels, but even the wads and the charges.

Benoit has re-examined the alleged relation between density and opacity to the rays, and finds certain discrepancies. Thus, the opacity of equal thicknesses of palladium and platinum are nearly equal, whilst their densities and atomic weights are very different, those of palladium being about half those of platinum.

At the last meeting of the British Association visitors saw—at the McGill University—Professors Cox and Callendar's apparatus for measuring the velocity of Roentgen rays. They found it to be certainly greater than 200 kilometers per second. Majorana has made an inde-

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pendent determination, and finds the velocity to be 600 kilometers per second, with an inferior limit certainly of not less than 150 kilometers per second. It may be remembered that J. J. Thomson has found for cathode rays a velocity of more than 10,000 kilometers per second, and it is extremely unlikely that the velocity of Roentgen rays will prove to be less.—Ex.

INSULATION.

MICA MINING IN INDIA.

This mineral, for which many useful applications are found in the arts, is mined in large quantities in Nellore, a maritime district of the Madras Presidency. The mineral is found near the surface, no subterraneous mining having yet been attempted. Mr. Robert W. Thompson, in the "Journal of the Society of Arts," tells us that mica occurs in masses of from 100 to 200 cubic feet, the method employed for detaching the stuff being blasting with gunpowder or dynamite. The cutting and sorting of the mica after it is won from the quarry is a very important part of the industry; the value depends not only on the sizes of the sheets, but also upon their freedom from flaws and their clearness and transparency. Slabs of clear mica have been obtained of a superficial area exceeding two square feet; such pieces are, however, rare. But pieces of no more than four square inches find a ready market. All clear mica is cut into rectangular pieces of certain sizes. The clippings, or waste, have hitherto been thrown aside as useless; but inquiries have recently been made for this waste, as the mineral is said to be useful as a lubricant when powdered. New uses are continually being found for the mineral. A patent has recently been taken out in India for a composition, in which it is the principal ingredient, for the covering of boilers, steam pipes, and the like, for it is an excellent non-conductor of heat. A cartridge has also been invented in which, instead of paper or metal for the wrapping, mica is used, the advantages of the material for this purpose being manifold. It is not easy to ascertain the actual cost of getting the material. That it is a very paying industry is clear from the eagerness with which both Europeans and natives are taking up land for mining.—Ex.

ELECTRICAL MACHINERY FOR GREAT BRITAIN.

The Westinghouse Electric and Manufacturing Company is crowded with British orders for street railway motors. There are 262 motors and eight generators to be turned out with all possible speed.

An abstract of the contracts on hand is as follows: For the Hull Tramway Company, 92 electric railway motors, to equip 45 cars and one track sweeper; for the Halifax Tramway Corporation, 12 motors to equip six cars; for the Bradford Tramway Corporation, 48 motors to equip 24 cars; for the municipality of Norwich, which has control of the tramways in that city, 80 motors to equip 40 electric cars, and four electric generators to be installed in the power house of the Norwich Tramway Corporation to generate the electric current for the operation of the line. For the City of Coventry, the greatest bicycle headquarters in all Great Britain, 20 motors have been ordered to equip 10 cars, and the order has been augmented by a call for two power generators. The well-known seaport of Plymouth has called for 10 motors and two power generators for operation of local electric railways.— Ex.

ELECTRIC RAILWAYS.

ELECTRIC RAILWAYS IN THE UNITED STATES.

To what extent electric railways have been developed in the United States, where, admittedly, they have prospered in a manner unparalleled elsewhere, is shown in a short chapter of statistics given in the annual report of 1897 of the United States Commissioner of Patents. The first electric street railway in the United States was put in operation only a little more than ten years ago. In 1880, of the 2,050 road miles of street railway in the country nearly all employed animal power. Electric power had not yet come into use, but a few miles of lines were operated by steam and by cable. The total number of persons then employed on American street railways was a few hundred short of 12,000. Ten years later, in 1890, the United States Census gave the number of street railway employees as 37,434, and at the close of that year the total mileage of street railways all over the country was given as 8,123 track miles, on 5,661 of which horses were used, while the remaining 2,462 miles were worked mainly by electric and cable power. The capital invested in these roads was $211,277,793, and 71,000 persons were employed on them. In 1894 the total milegae was 12,527, of which 7,470 was electric. The capital invested was $648,330,755, of which $423,493,219 were invested in electric railways. One hundred and ten thousand persons were employed on street railways in that year. In 1896 the mileage had increased to 14,470, of which 12,133 miles were electric. The capital invested was $784,813,781, and the number of persons employed was not less than 140,000. The total mileage of electric railways in the United States up to October of 1897 was 13,765 miles, out of a total mileage of 15,718, and of these but 947 miles were horse car lines. The total capital invested was $846,131,691, and the number of employees may be safely estimated at not less than 166,000.—Cassier's Magazine for January.

MISCELLANEOUS.

COST OF COPPER FOR TRANSMISSION CIRCUITS.

In a paper recently read by Mr. Chas. F. Scott, electrical engineer of the Westinghouse Electric Manufacturing Company, and embodied in a paper on "Electricity in Paper Making," read before the American Paper and Pulp Association, gave his conclusions as to the efficiency of electrical apparatus in the following words: "The full load efficiency of generators, both of direct current and alternating current, varies with the size and type, but for machines of 100 horse power and over the variation may be from 90 or 91 per cent. to 95 or 96 per cent. The efficiency of alternating current transformers, in the same way, may be said to vary from 96 or 97 per cent. in sizes less than 100 horse power and 97 to 98 per cent in larger sizes. The efficiency of motors, both for direct and alternating current, varies from 80 or 85 per cent. to 90 per cent., in sizes from 5 to 100 horse power, and is 90 per cent. to 96 per cent. for larger sizes. Efficiency of transmission lines and distributing circuits depends upon the E. M. F., the amount of copper and upon the cost.

"The approximate efficiency of a transmission plant will therefore be between limits about as follows:

Generators	90 to 96	per	cent.
Raising transformers	95 " 98	"	"
Transmission line	90 " 95	"	"
Lowering transformers	96 " 98	"	"
Local wiring	97 " 99	"	"
Motors	85 " 96	"	"
Efficiency of plant	61 to 83	per	cent.

"In local distribution from low voltage generators the losses in raising and lowering transformers are, of course, eliminated, and the range of efficiency becomes 66 per cent. to 86 per cent."

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THE CLOCK OF THE FUTURE.

The New York Standard Company has succeeded in perfecting an electrical clock movement which overcomes all clock difficulties hitherto existing. The ordinary dry battery furnishes the motive power for the clocks and is concealed within the clock case. The movement runs equally as well with weak as with strong cells, automatically compensating for fluctuations in strength of current. The clocks are regulated in the ordinary manner by raising or lowering the pendulums to increase or decrease rate. Because of the ingenious and original method by which the power is applied in these clocks more nearly accurate time is obtained than is possible wtih any other movement. The best makers of mechanical clocks consider that a variation of a second a day is very close running, but clocks installed in this city by the New York Standard Watch Company have shown a variation of only four seconds after a run of thirty-four days. These clocks are the only ones that have ever given satisfaction in the Weather Bureau, New York City, oscillations of the tower in which it is situated having heretofore interfered with the running of the clocks placed in the same. One of the No. 10 has been running in the highest room of the tower for six months and given perfect satisfaction. At the end of one run of sixty-eight days the variation was only sixteen seconds. The movement consists of an electromagnet and armature so arranged as to give occasional impulses to the pendulum whenever an automatic switch closes the battery circuit. These impulses do not occur at fixed intervals, but their frequency varies with variations in the strength of the current. As the battery weakens the impulses occur more frequently, automatically compensating for fluctuations and strength of current in obtaining the greatest economy in the use of the battery. The pendulum, for the most part, is acted upon only by the force of gravity. Motion is imparted from the pendulum direct to the going train by means of a pawl of the simplest order. The electric clock, as perfected by the New York Standard Watch Company, seems to be without doubt the "clock of the future" and bound to supersede the winding clock as the stem winder has replaced the key winder. For further information address the New York Standard Watch Company, 11 John street, New York City.

BUSINESS NEWS.

NEW INCORPORATIONS.

Columbia, Cal.—Tuolumne County Water and Electric Power Company has been incorporated by J. W. Ellis, William Mansfield, Thomas Conlin and others to furnish water and electric power and light. Capital stock $143,000.

Albany, N. Y.—The Manhattan Lighting Company of New York, has been incorporated by Henry D. Brenner and others. Capital stock $250,000.

Big Rapids, Mich.—W. E. Douley Electric Light and Power Company, incorporated by W. E. Douley, J. S. Douley, D. M. Martindale, J. W. Morton and W. I. Tice to supply electricity for light, heat and power. Capital stock $40,000.

Swedesboro, N. J.—Swedesboro Light, Heat and Power Co., has been incorporated by Charles D. Lippincott, Henry M. Mitchell, Thomas B. Turner, John C. Rulon, Benjamin F. Lawrence and James J. Davidson. Capital stock $25,000.

Peoria, Ill.—Perry Electric Company, incorporated by N. U. Perry, R. E. Seymour and D. R. Chapman; electrical signal telephone. Capital stock $2,500.

New York, N. Y.—Wm. Porter's Son Company has been incorporated by Annie M. Porter, W. H. Porter and N. F. Porter to make fixtures for burning oil, gas and electricity. Capital stock $100,000.

POSSIBLE INSTALLATIONS.

Somerville, Tenn.—T. B. Yancey, Mayor, may be addressed concerning construction of electric light plant.

Pierre, S. D.—The new city electric light plant is now in course of construction.

West Concord, Minn.—E. W. Vanorman will shortly establish an electric light plant.

Lonaconing, Md.—The Lonaconing Electric Light and Power Co. will improve its electric light plant.

WESTON STANDARD ILLUMINATED DIAL

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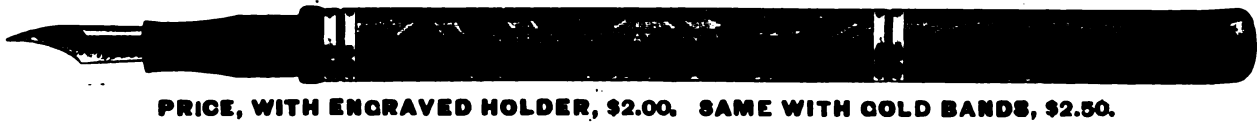

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The Electrical Age.

VOL. XXII—No. 27 NEW YORK, DECEMBER 31, 1898 WHOLE NO. 607

ELECTRIC RAILWAYS.

Fig. 1. Laying Ducts for Electrical Equipment of Broadway Cable Road.

(Courtesy of the "Scientific American.")

EQUIPMENT OF THE BROADWAY CABLE LINE WITH ELECTRICITY.

In recent issues the "Scientific American" has described at considerable length the important changes which are being made in the great system of surface roads owned and operated by the Metropolitan Street Railway Co. These changes include the construction of four important north and south lines of railway on the underground trolley system on Second, Fourth, Sixth and Eighth avenues, with connecting cross lines at Fifty-ninth and Canal streets, the changing of the Broadway and Lexington avenue lines from the cable to the underground trolley system, and the equipment of a crosstown line from the Hudson to the East River with compressed air motors. When the work which the company has now in hand is completed, 90 miles out of the total of 228½ miles owned by the company will be mechanically operated. In the course of time it is intended to apply electric traction to the whole system, with the exception of some crosstown roads. If the use of the compressed air motor on the Twenty-third street line shows good results, it will be adopted on other crosstown lines.

The electric roads are entirely new construction, the old horse-car tracks having been removed in toto to make way for the cast-iron yokes and massive 107-pound rails which are the standard construction for all the new electric roads. On the Broadway road, on the other hand, the whole of the original track construction is available, and the changes are confined to laying of the cable ducts and bolting the conductor rails to the lower flanges of the slot rails within the conduit.

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The ducts are laid in a trench which is excavated at the side of the tracks and slightly under them, as shown in the accompanying illustration, Fig. 1. Two kinds of duct are used, one consisted of riveted sheet iron pipe about four inches in diameter, lined internally with cement, forming the top layer of twenty pipes, the other being made of terra cotta in short lengths of about two feet.

The object of these numerous ducts is to carry independent conductors to different sections of the road, providing current, in case of accident to one section, to all the others, reducing to a minimum the possibility of delay on long stretches of road at a time.

The terra cotta ducts are preferred for the high tension current cables. In laying the ducts, the bottom of the trench is leveled and covered with from four to six inches of concrete. The ducts are then arranged symmetrically in layers, and cement grout is run in between them to fill up the voids and bind the whole mass together. The sides and top are also concreted in, thus insuring that the continuity of the several lines of duct shall be preserved unbroken. Piles of these ducts will be observed on the sidewalk to the left ready to be placed in position. This work of transformation is going on without the least interruption to the regular cable traffic.

The conductors consist of two lines of T-shaped rail weighing twenty-one pounds to the yard, which are suspended below the cable slot by means of insulators attached to the lower flanges of the slot rails. The insulator consists of a circular cast-iron cup, provided with lugs by which it is bolted to the slot rails. Within this cup is another of porcelain, which is held firmly within the cast iron cup by cement. The porcelain cup holds a 1½-inch wrought-iron shank, to which the conductor T-rail is bolted.

To enable the conductor rails and their supports to be put in place, two handhole boxes are being placed, one on each side of the slot, at every fifteen feet of the Broadway track. The conductor rails will be in thirty-foot lengths, so that it will be possible to slide them into the conduit at the handholes. They will be supported at the ends and at the middle. After the insulators and conductors have been passed in through the handholes and bolted up and the wiring to the cables in the ducts completed, the Broadway road will be ready for the electric cars, which will commence running early in 1899.

Fig. 2. Construction of Underground Trolley Road on Canal Street, New York City.

(Courtesy of the "Scientific American.")

The present Broadway cars can be used by equipping them with motors, and replacing the present grip by an electric plow. It is probable, however, that new and larger cars of the type at work on the present electric roads of the company will be supplied for this, the most important artery of travel in New York City.

In the underground trolley system as now being installed the track rails play no part in the electric circuit. The current is conveyed to and from the motor by means of the plow, one side of the plow receiving the current from the feed conductor and the other side delivering it to the return conductor. The shank of the plow consists of three steel plates,

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the outer plates being one-eighth inch and the inner plates three-sixteenth inch in thickness. The conductors, which are wrapped copper ribbons, are carried down through the plow to the contact shoes or wipers, connection being made between them by flexible cables. The shoes are of cast iron and measure four inches by one-half inch. They are kept in contact with the conductor rails by means of side steel springs, which keep the shoes eight inches apart when free and six inches apart when they are in contact with the conductor rails. It has been found that a pressure of about six pounds is sufficient to insure good electrical contact between shoes and conductors.

The engraving, Fig. 2, shows a portion of the new underground trolley road in course of construction in Canal street. Under the slot is seen the sheet iron drain tube and to the right another form of terra cotta ducts, each section having four tubes about six feet long. By comparing it with the view of the Broadway road it will be seen that the new track is considerably heavier. The rails, weighing 107 pounds to the yard, are not only the most massive used in any street railway, but they are several pounds heavier than the largest rails used on the steam railroads, where the most massive rails do not exceed 100 pounds to the yard. This is the weight of the rails on main line of the New York, New Haven & Hartford Railroad and on certain stretches of the New York Central and the Pennsylvania Railroads.

Current for the whole of the underground system, including the Broadway line, is eventually to be furnished from one great central station at Ninety-sixth street and the East River. It will have a capacity of 70,000 horsepower, or over four times that of any existing power station in this country. The plant will consist of 87 watertube boilers of 800 horsepower each; 11 cross-compound engines, each of 6,600 horsepower; and 11 direct connected three-phase alternating current generators. The current, at 6,000 volts, will be led to eight substations, conveniently located with reference to the various lines. Here it will be converted by static and rotary converters to a pressure of 550 volts, at which it will pass to the conductors.

TELEGRAPHING WITHOUT WIRES.

TESLA'S LATEST INVENTION.

C. D. Wood, in the "Yale Scientific Monthly."

For many years there was but one man to whom our country could look for its advancement in electricity. Thomas A. Edison was the undisputed leader, and his word was law in the world of applied electricity. In the past few years there has been another man to step to the front, and through his skill and persistent mastering of difficulties he has obtained a similar or even higher position in the world of science.

Nicola Tesla is not an American by birth, but as his name implies, was born in Austria. Thinking that an opening was in store for him in this country, he made it his home, and to it he has contributed the results of his discoveries. Tesla's career has been one of difficulty. On two different occasions his laboratory has been on fire, and several important models were destroyed, on which he was still working.

For the past year the young inventor has been studying the problem of conveying electric currents without visible conductors. He has proved the theory concerning the ability of waves of ether to carry electricity, and has brought it to a practical test by making luminous, without the aid of wire, cylinders suspended in the middle of a room. He now claims that it is possible, without the aid of other media than the earth and the atmosphere in a certain state to transmit large quantities of electricity an indefinite distance. The transmission of such currents for long distances would open up a field of electrical engineering the extent of which would be hard to conceive. It is well known that air, when enclosed in a vessel, can be so rarified as to destroy its insulating properties, and become a fair conductor. If the so-called electrical pressure at a certain point is sufficient, and that point be elevated so as to obtain the proper rarefaction, the electrical energy at the point can be conveyed to an indefinite distance.

Tesla has invented a machine (if it may be called that) by which, without danger to the human body, he can produce an electrical pressure to the amount of 2,500,000 volts. As the conductivity of the air increases directly as the pressure, the more current produced, the greater is the efficiency of the air to carry the particular current.

Tesla's generating apparatus or transformer, as he calls it, consists of a secondary coil, built up as usual around an iron core and wound with a large number of convolutions. This coil is surrounded by another, having wire of heavier diameter, but wound with fewer convolutions. This comprises the primary or low-tension coil, and is electrically connected to the secondary, in order that there may be no difference of potential. The length of the secondary coil is now to be considered. That the greatest possible electrical pressure may be obtained, the length of coil should be equal to one-quarter of the wa length of the electrical disturbance in the circuit.

The current in this case may be supposed to travel 182,000 miles per second; there a frequency of 925 per second would maintain 925 stationary waves; hence, each wave should be 200 miles long. Tesla proposes that his coil shall be 50 miles in length. The current coming from the terminal connected with the earth traverses the transformer, and is led by an ordinary conductor to an elevated station. This elevated terminal is generally a rounded surface suspended at a height which insures the rarefaction of the air necessary to conduct that particular current. If the potential is high enough and the surrounding conditions of the country favorable, the air will offer less resistance than an ordinary copper conductor. If there were mountains in the vicinity, the elevated terminals would have to be placed upon them, for a large portion of the electricity would otherwise escape to the higher ground.

Situated at an equal elevation at the receiving station, we have a terminal similar to the one just described, and connected with the receiving transformer. The machi resembles the first transformer, except that the coils are in a reversed position. The inner coil with the greater number of convolutions acts as a primary, and the low tension coil takes the part of the secondary. Another conductor completes the circuit by carrying the current to the earth. In the circuit of the transformer lamps, motors or any other machines for the utilization of current are placed. Such is the practical application of the new theory. These elevated terminals might be suspended from balloons, or placed upon high promonitories, provided the elevation is sufficient.

This scheme of transmitting electricity appeals to the business man as well as to the scientist, for he can readily see what large incomes could be realized with comparatively moderate expense. If the Kings County Electric Power Company of Long Island, which is now the largest electrical concern in the United States, could utilize the power of Niagara by this new method, they could do away with their several power houses and cut down their expenses one-half. This invention has not been the product of a small amount of work, but the outcome of long series of experiments and careful study on the part of the inventor. Tesla is purely a man of science. His connection with Edison was severed because he did not believe in a scientific life for the money that was to be found therein. He believed in giving his inventions to the world with unrestricted freedom, differing from his older partner, who was the business man, as well as the inventor.

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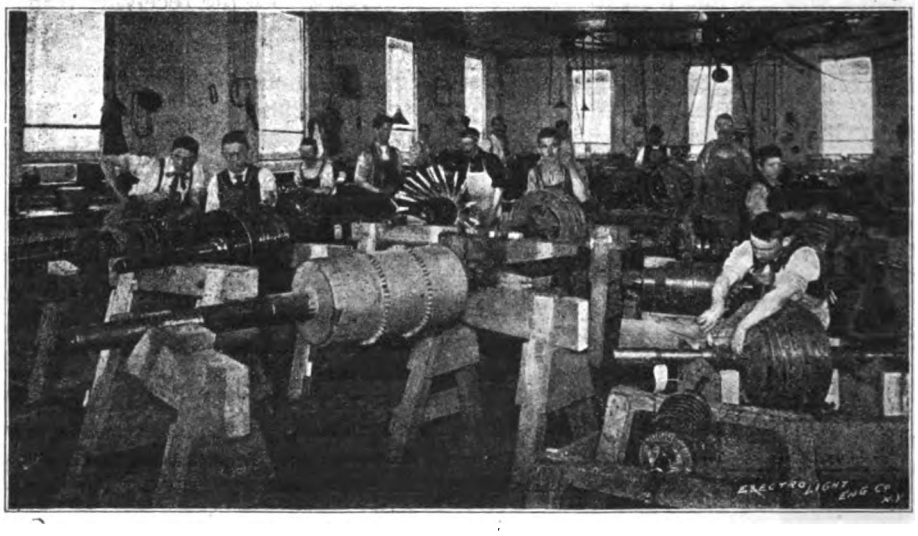
ELECTRIC LIGHT AND POWER APPLIANCES.

REPAIR SHOP PRACTICE.

Divided as it is into many departments the repair shop is called upon to improve and in many cases to completely rehabilitate a generator or motor turned in for renovation. Due credit has not always been given to those entrusted with such responsible work. The change of voltage required may involve a modification in the winding of both armature and field of so radical a nature that virtually an entire redesign is necessary. Frequently those interested commercially in the running of shops for either general repairs or manufacturing purposes find themselves at a loss for the need of a few pointers. In field winding, for instance, one of the proofs that it is correct may be applied as follow: Divide the size of the wire in circular mils by one thousand. If the result gives the number of amperes the coil is going to carry the size of the wire is correct. To decide upon the proper resistance divide the difference of potential at the terminals of the coil by the current the coil will carry and the resistance is obtained, which should be equal to that of the length of wire chosen. For instance, ten thousand circular mils or a number ten wire, divided by one thousand gives ten amperes, the maximum current the coil will take, provided its resistance is correct. At one hundred and ten volts the resistance of the wire should be equal to one hundred and ten divided by ten or eleven ohms. If the length of wire used for the coil has ten thousand circular mils cross section, but is of a greater resistance than eleven ohms it will not take ten amperes at one hundred and ten volts pressure.

In fitting together a wrought and a cast iron surface generally met with where the magnet core and keeper or magnet core and pole piece meet, care should be taken to see that their respective cross sections are correct at the point of contact. In the sketch the cores made of wrought iron are set into a cast-iron keeper for the purpose of securing not only mechanical strength, but enough cast iron surface to allow the lines of force from the wrought iron to pass freely in without being throttled. The ratio that is safe to employ as far as the areas of contact are concerned are one square inch of wrought iron to two square inches of cast iron. The lines of force per square inch in the wrought iron at one hundred thousand would mean two square inches of cast iron in contact, each carrying fifty thousand lines of force. In armature winding the two general divisions are lap and wave winding. Lap winding is generally met with on bi-polar armatures and the so-called multiple wound generators. A wave wound generator is suplied with less brushes than pole pieces, whereas a lap wound generator generally possesses as many brushes as pole pieces. Wave winding applies to the winding of an alternator. An armature of this description with pan cake coils is found to possess a winding, each coil of which is reversed with respect to the other, and none overlap. To double the electro motive force of a generator it is simply necessary to double the number of external wires on the armature and halve the cross section of the wire. To double the current the reverse is practical, provided the number of active inductors are reduced to one half.

Commutator Repair and General Machine Shop.



Rewinding Department.

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THE ELECTRIC LIGHTING OF PRIVATE RESIDENCES.

It is manifestly impossible to anticipate the system of electric lighting which will be used in private residences. To light one's home, not as a mere matter of experiment, but with the intention of making it an economical and convenient practice is a proposition inherently interesting. It is strange to realize the efforts that are being made by concerns manufacturing small gas, gasolene and acetylene plants, to impress the general public with the direct benefit in money and convenience of such installations. Electric lighting in private residences is to us as important a problem as the illumination of homes by the above mentioned material is to those representing such interests. Domestic electric light plants at this late hour should be as familiar a feature of kitchen economy as the ice cream freezer or the gas stove. Strange to say, the interest taken by electrical engineers in this exceedingly broad and profitable enterprise is rather limited in its nature. In all probability the reason is due to the absence of a small motor, the construction of which would be so simple or at least so perfect that Bridget could be left in full charge of the apparartus. Electrical men believe that the public must be educated up to certain improvements, and learn how to use them, but this is a mistake. Engineers must be educated up to the demands of the general public and learn to accommodate them. This would save us from tons of complicated and useless machinery, which is theoretically valuable and interesting, but in practice is found to be unreliable and a general nuisance. The three plans worthy of consideration for electric lighting in our homes are as follows: First, the use of electricity from the street circuit; second, the introduction of small electric light plants for individual lighting; third, the installation of a block system. The sale of staple articles encourages us in the idea that the sale of electricity by large central stations is in perfect harmony with modern practice. But it will only be profitable to the general masses when the price of such power will meet all criticisms and remain unaffected by it. In this respect, the price of staple articles, among which electricity will soon be considered, naturally sinks to a certain figure, generally allowed as correct and approved of by the public. In consequence of this it is but a question of time to wait until this fair price is established. On the other hand, the introduction of small electric light plants is practical and may prove to be profitable, provided the saving brought about by their use will cover the cost of two or three years' illumination otherwise obtained. Referring for a moment to the block system of electric lighting, a system in which a miniature central station is established in the yards of a city block and from which power may be obtained to light all the houses surrounding it, this system, let it be understood, possesses obvious advantages. It might be regarded as one of the outcomes of communism or merely as an effort on the part of bread winners composing a city block to co-operate for the purpose of lighting their homes in their own way and at their own expense. To illustrate, take a square block of city houses, numbering about fifty, let them average about ten lights apiece or a total of five hundred lights. A bill against each of $100 a year for lighting would not be considered exorbitant. At this rate the annual receipts would be $5,000. The cost of fuel and the expense of running the plant would amount to $2,500. Allowing $2,500 for the plant itself, and a little wiring, would mean a complete financial balance at the end of the year of cost of installation and runing expenses against the cash receipts. The second year, allowing the expense of running to equal $3,000, the cost per residence for electric lighting would average only $60, for which sum ten lights could be run eight hours a day, every day in the year. A private plant would take longer to pay off, but it seems as though it were no more sensible to pay rent for the use of furniture or necessary articles of home use than to pay for either light or power in the home. A well-designed gas or kerosene oil engine, direct connected to a small generator of about two horse-power size, costing, say, $300, would pay for itself in the course of two years, and be acceptable to 50 per cent. of the owners of private residences. To people of moderate means the proposition is certainly an interesting one, and of prime importance, if time and a slight degree of labor are freely given as the full equivalent of what may be thereby saved.

A GERMAN ELECTRIC HAULAGE PLANT.

At the Altenwald coal mine, in the Saar district, the water from an upper level is used for working a 24-H.P. Girard turbine, the horizontal shaft of which drives directly a shunt-wound dynamo which, with 480 revolutions per minute, gives out 13 kilowatts at a tension of 440 volts. The current is led to a cross-cut, where, at a distance of about 600 m. from the shaft, a 12-H.P. electromotor drives, by spur gear, an endless-rope haulage plant on gradients varying from 2 degrees to 8 degrees, conveying from 250 to 300 tons for a distance of 1,200 m. This plant has given complete satisfaction from both a technical and economical standpoint.

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MISCELLANEOUS SCIENCE.

STRAY CURRENTS.

SEASONING LUMBER BY ELECTRICITY.

A new process is announced for seasoning wood by electrical action. The timber to be treated is put into a quadrangular tank of liquid, immersed to rather more than half its depth, and an electric current applied through a metallic conductor, so arranged as to distribute it throughout the area, and it is stated that in a space of four minutes the sap begins to exude at the lower end of the wood; in six hours it is all extracted. The wood is then placed in another tank, from which a septic solution is forced into the pores by an electro-capillary method. If, says the "Builder," this process has successful results at a cost which will not be commercially prohibitory, it may prove of great importance.—Ex.

ELECTRICITY AT PORT HEYST.

Port Heyst is now rising at the mouth of the ship canal joining Bruges to the North Sea. It is, therefore, sometimes called the port of Bruges, but such names have not much to recommend them. A very general use is made of electric motors at the port. Two Willans engines of 250 horse power are coupled with two continuous current generators, which feed the various electric motors in the brick works, smithies and workshops. The conductors are aerial. The power is not always sufficient to deal with the huge beton blocks for the caissons, which are being moved with the help of two electric derrick cranes. The power installation is, therefore, being enlarged.—Ex.

STEEL FOR MAGNETS.

The results of tests of a large number of magnets made of self-hardening steel, now in common use for lathe tools, are given in the "American Journal of Science." The object of these tests was to search for a material for standard measuring magnets which would be as permanent as possible, and have a small temperature and induction coefficient. The experiments show that comparatively short seasoned magnets made of this steel have decidedly smaller induction coefficients than magnets of the same dimensions made of tool steel; the difference in the temperature coefficient is much less, but the advantage is still on the side of those made of self-hardening steel; the temperature and induction coefficients of long magnets of the two kinds of steel do not seem to be very different.—Ex.

AN ELECTRIC ICE MACHINE.

Mr. Thomas J. Fay suggests a system by which electric plants may supply the wants of users of refrigeration without adding the details of the ice business to troubles of their own. His proposition is, in brief, to supply electricity to small individual plants, such as those used by meat markets, in which the current would be utilized in an ice machine, of which the motive power would be electricity instead of steam. Mr. Fay has designed and experimented with several such machines, with results which he regards as satisfactory; and he gives figures to show the cost of ice production. He is of the opinion that sooner or later automatic electrical equipment will "drive out the cold effrontery of the peddlers of ice, whose pedigree may not stand a close inspection."—Ex.

ELECTRIC FLOOR-SCRUBBING MACHINE.

Electricity has been brought into the service of domestic economy for various duties, but it is something new to utilize it in the cleaning of floors. An American inventor has devised and constructed an electric floor scrubber, of which great things are said. It is claimed that this little machine can do this kind of work in one-fourth of the time usually required in manual labor, at a saving of 75 per cent. of the cost. It is designed for use in Government, State and large office buildings, hotels, stations, hospitals, halls, etc. These machines are said to have been already in use in various buildings, in one instance doing work on eight floors in two and one-half hours, which previously required ten and one-half hours to perform by hand. The number of hands is not stated, however. For the scrubbing brushes, sandpaper blocks or blocks of stone may be substituted, and thus the machine may be used to dress down wood floors or mosaic.—Ex.

THE PRODUCTION OF COPPER IN JAPAN.

Very considerable is the copper production of Japan, there being at present seventy mines. During the fiscal year ending June 30 last, 35,000,000 catties, or about 500,000 centners, of copper, valued at 5,800,000 yen (about $3,000,000), were mined. Since 1875 the copper production has increased almost ninefold. Most copper is sent to Hong Kong, then to China and to England, the total export amounting to 350,000 centners, i. e., five-sevenths of the whole production.—Ex.

TIPS ON TRADE JOURNALS.

THE TRADE JOURNAL FOR ADVERTISERS.

There is no species of journalism, says "Fame," more essentially modern or more a product of recent years, than the trade journal. Its development is really a matter, for the most part, of the last two or three decades, and while there is a considerable number of papers and periodicals in the trade line that show weakness of grasp, and that must yet make their foothold, those which have gained a foothold are among the most stable of journalistic properties.

That the trade journal is greatly appreciated by people for whom it caters goes without saying. There would not be so many attempts to start a weekly or a monthly for every trade or business if this were not so. Of course, the getting a trade journal established depends primarily upon its ability to help or interest its readers, and not less upon its ability to secure advertising.

It may possibly be an apt comparison if I say that an established trade journal has the same excess of value to its clients over other papers that a physician who is a specialist has over other physicians for his patients.

The advertiser in a trade journal is mainly one who offers some commodity or service to persons engaged in a particular trade. The circulation of the paper represents a class of people, every one of whom can be considered and addressed as a possible patron. That they are intelligent above the human average is certain, or they would not take a paper devoted to one topic. And that they are worth addressing is equally sure, for each one must be an interested reader of the trade advertisement addressed to the trade.

For the above reasons it is not, perhaps, an exaggeration to say that every 1,000 of circulation in a trade paper is worth to any advertiser in the trade concerned any 10,000 or more of circulation in a paper addressing the general public.

The truth is, in the trade paper the advertiser offering something special to the trade represented has his "game," so to speak, directly before him. Every shot he sends forth hits the exact mark. On this account it will not do to despise a trade journal whose circulation is only in the hundreds, since these hundreds are pretty sure to read the advertisements, and to read them for a more definite and practical purpose than curiosity.

It is not true, of course, that every reader of intelligence takes a trade paper, but it is sure that every reader of a trade paper is sure to take other journals, and this one fact goes to show the intellectual quality of the constituencies the trade journal represents.

It is the consideration of this fact that makes advertisers also—who are not of the trade—use the trade journal. Such a one as the "Northwestern Miller," or the

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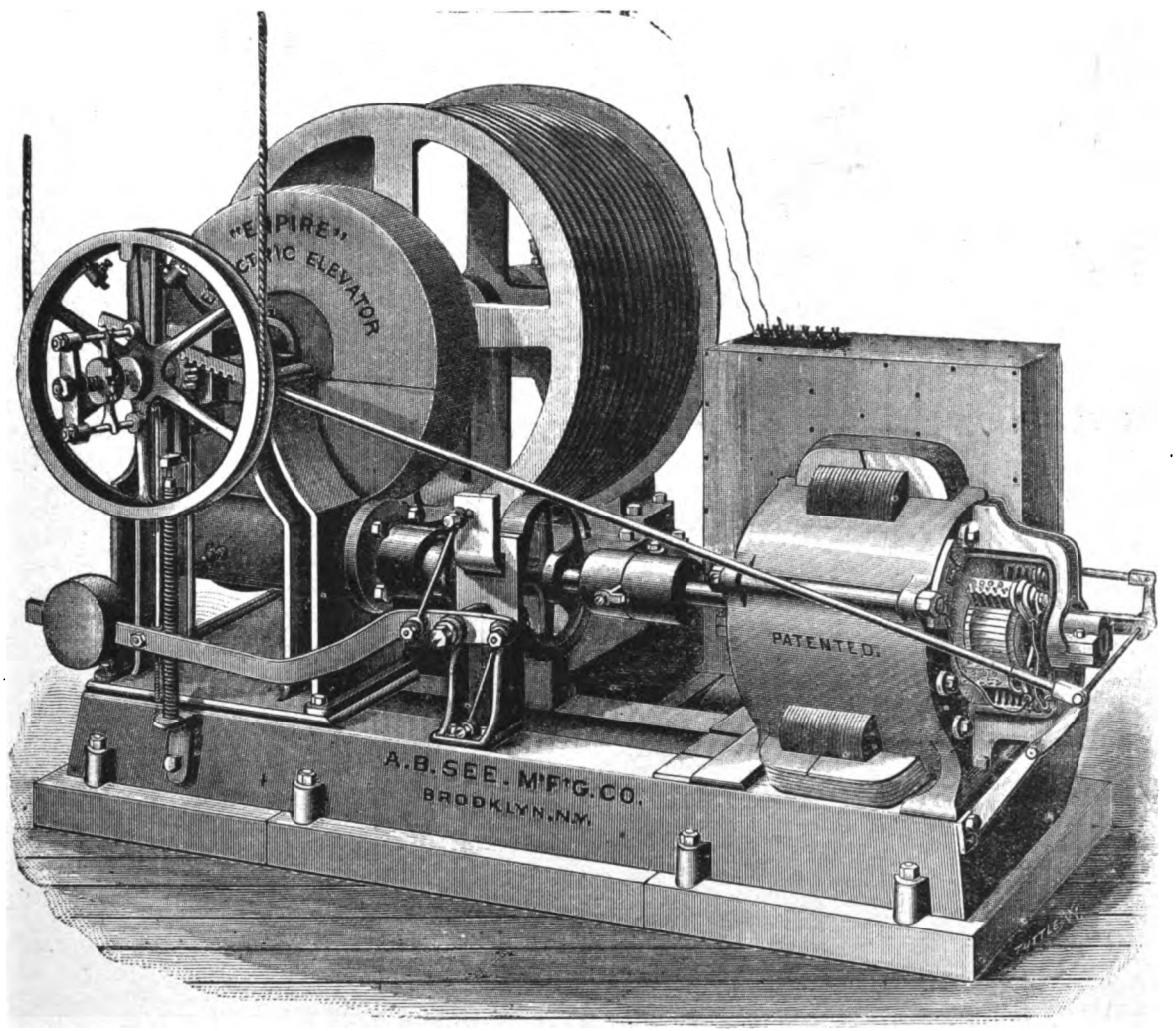
"Northwestern Lumberman," or the "Dry Goods Economist," or the "Iron Age," whose circulations are presumably large, and which have widely known names, can demand and get advertising not special to their direct line of thought and exertion. And such advertising ought to be justified; of course it is, or it could not be so offered and so generally secured.

DYNAMO DESIGN.

MOTOR CALCULATIONS.

The construction of a motor is largely governed by the nature of the work it is supposed to perform. A motor used in connection with a pump is called upon to stand a steady and comparatively uniform load. A motor designed to meet the variable load of an elevator must be prepared to resist sudden shocks, as it were, and an immense number of variations in load. The horse power required to lift an elevator is easily calculated by multiplying the weight of the elevator and its contents by its speed per minute. One thousand pounds moving upward at the rate of thirty-three feet a minute would call for one horse power without any consideration being taken of friction and losses by power transmission. The efficiency of an elevator system depends largely upon these losses, although the motor itself controls the general loss by virtue of its design. For pumping, the horse power consumption is not subject to such fluctuations as in the previous case. One cubic foot of water weighs one thousand ounces, or sixty-two and one-half pounds, and contains seven and one half gallons. The weight of one gallon is eight and thirty-three hundredths pounds. Consequently a column of water pumped one foot vertically, having a cross section of one square inch, would weigh .434 pounds. From this we see that every additional foot in height to which the water is pumped will mean an additional pressure of .434 pounds. The horse power for a given number of gallons depends upon the number of feet to which it is to be lifted, the number of gallons pumped per minute and the weight of a gallon in pounds. To lift twenty-four thousand gallons six hundred and fifty feet per hour means the lifting of four hundred gallons per minute. Multiplying four hundred by six hundred and fifty feet and dividing by twenty-six hundred a constant will give one hundred horse power. This means an allowance of only thirty-four per cent. for the various losses that occur throughout the system. The efficiency in such a case would lie between 60 and 70 per cent. In elevator or hoisting work the efficiency of the motor may average seventy per cent., in which case this allowance will have to be made and an additional safety factor to provide against contingencies. Vertical traction differs from horizontal propulsion only in the matter of friction and possibly in relation to the unimpeded downward descent of the passenger or freight elevator. An electric pump used in hydraulic elevator work would consume power depending upon the gallons of water pumped per minute and the pressure in pounds per square inch. By multiplying these two together and dividing by eleven hundred and thirty the horse power required is obtained, allowing for friction, etc. To conclude, an elevator using



Electric Elevator, Showing Connection Between Hoisting Drum and Motor.

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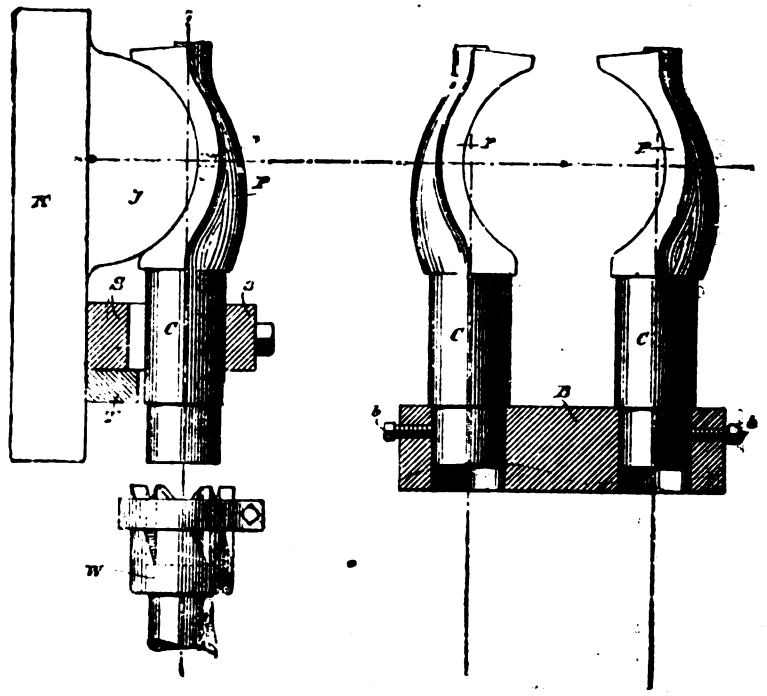
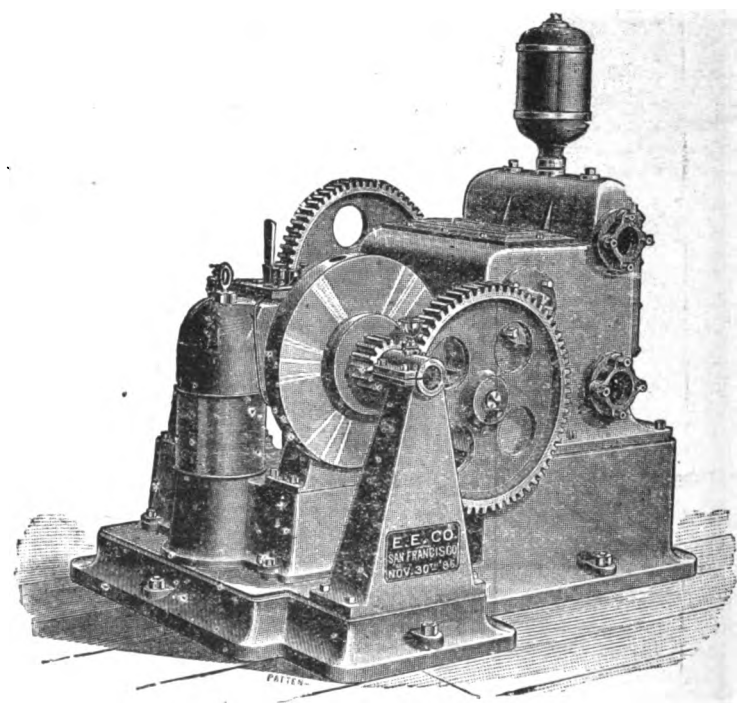
three hundred gallons of water per minute at one hundred pounds pressure would require a motor whose horse power equals three hundred times one hundred divided by eleven hundred and thirty, or twenty-six and one-half horse power.



Method of Making Joint Between Wrought Iron Cores and Cast Iron Base.

DYNAMO ARMATURES.

The best density to use in the magnetism of an armature is a question on which dynamo engineers seem to differ very widely. An examination of the various machines in practice discloses the fact that armature densities varying from 40,000 to 90,000 lines to the square inch are considered as suitable by various designers. The desirable features of the one practice may often be profitably sacrificed to secure the advantages of the other. The strength of the induction, therefore, depends more on the conditions that are to be met in the design. If, says the "American Electrician," slow speed is desired above all else, there is no escape from high density. If, on the other hand, over load capacity is desired, high density is to be avoided. It is not to be inferred that a machine in which the armature is highly magnetized is of light weight, for as a usual thing little is gained in this direc-



A Compact Electric Pumping Plant.

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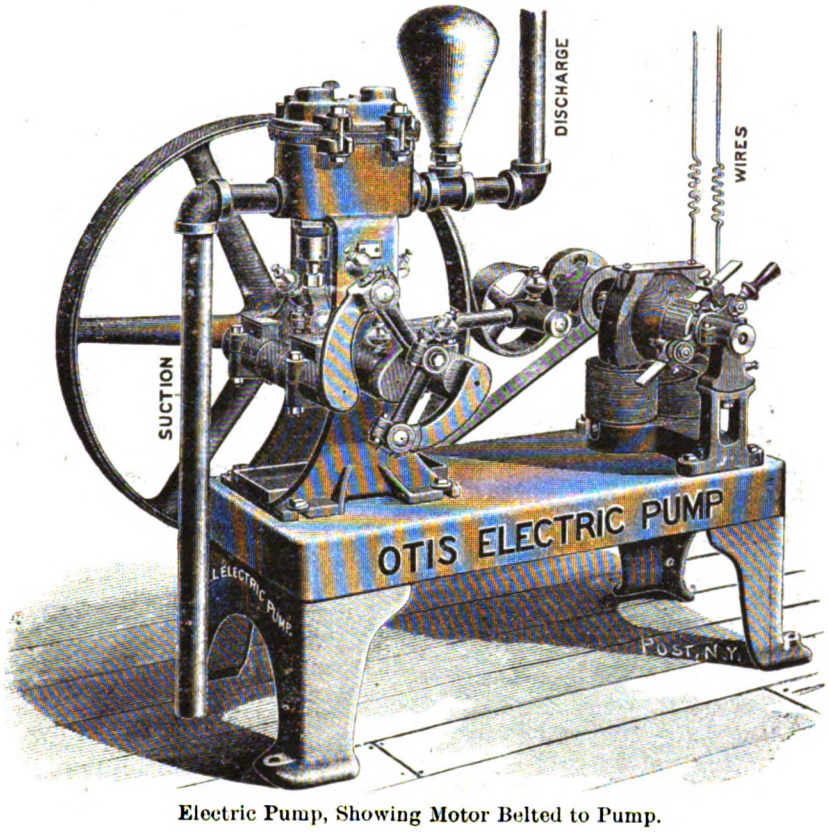
tion by such a practice. The diminished area of the air gap will increase the reluctance and the leakage in sufficient measure to demand a field magnet and exciting coils of added weight. A ring armature which is inherently larger than a drum armature of equal output may work at a higher density, for it does not suffer as seriously by a diminished air gap. The necessity of carefully selecting the iron to be used in armatures to work at high densities is by no means imaginary. Iron, or rather steel—for all modern sheet iron is such—is frequently so highly susceptible to hysteresis losses that if incorporated into a core, it would heat dangerously when in operation from hysteresis alone. Indeed, of two armatures made of different iron but otherwise identical, one will often burn out and the other show itself capable of carrying heavy overloads. The difficulty, if not the impossibility, of uniformly procuring good iron is certainly a temptation to lower the induction. The consensus of modern opinion seems to be that density is somewhat like speed; it may be increased above a certain limit to gain other advantages, but as a general rule the density cannot be increased over 50,000 lines to the square inch without serious sacrifice.—Ex.



Electric Pump, Showing Motor Belted to Pump.

WIRELESS TELEGRAPHY.

The following is a translation of an article by M. Ducretet, explaining his theory, which has just furnished interesting practical results:

The starting point was the discovery by Henri Hertz, in 1889, of electric waves analogous to waves of light. A machine invented by him enabled one to perceive the diffusion of electric vibration at a short distance.

Prof. Popoff, a Russian savant, was on the point of applying this discovery to telegraphy in 1895, when he learned that M. Branly, a Frenchman, had already invented the tube seen in my machine and which is the essential point, as this puts in motion the electric currents, or, to use the technical term, the inducting currents.

M. Branly has not received the proper share of praise for his important invention. In 1890 he had already observed the action of electrical radiation on metal filings, free or agglomerated, placed in an insulator between two conductors forming a circuit made by a battery and a galvanometer. The filings, primitively insulated, or of very high electric resistance, become conductors when they are struck by an electric wave. This conductibility is destroyed by a blow, but reasserts itself when the filings are struck by a new wave.

M. Branly has given the name of radio-conductors to his tubes made of filings. This name suggests that their conductibility springs from the influence of electric radiation, produced by any source whatever. The sensitiveness of this transmitter is extremely great.

Prof. Popoff first used his own machine to register electrical waves produced by atmospheric disturbances; he then demonstrated that it could be practically employed in the navy for long-distance signals. England immediately commenced experiments with a machine based on the same principles and with which, it is said, messages have been sent between Bournemouth and the Isle of Wight.

Experiments have been made in Paris and quite recently at Brest, where Mr. Tissot has successfully communicated with a point 1,800 meters (5,905 feet) distant. I have covered a distance of 4 kilometers (2.48 miles), and the transmission was as clear, even through a fog, as between the Pantheon and my laboratory, rue Claude Bernard. I have reason to believe that still greater distances will be compassed. The chief difficulty will be to find two points at sufficient distance and at the same time high enough not to be hidden from one another. The success that has crowned our efforts is due to the improvements I have made in the receiving machine, and particularly in the Branly tube.

It can not be concluded from our experiments that Hertz telegraphy will take the place of ordinary electric telegraphy, but experiments already prove the value of this system for the exchange of signals betwen ships and the shore, for lighthouses and exploring service, and for communication in our colonies—African and Asiatic. In town, posts could be readily established by using win-

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dows and towers on high buildings very far apart. The only objection would be that all machines favorably situated would receive the telegrams from one transmitter. This would render telegrams public property, unless a secret alphabet were adopted.

The receiving machine may be utilized for other purposes than communicating the current to a telegraphic machine; a row of incandescent lamps can be lighted, for example, or the fuse of a mine touched off. It is merely a question of sufficient force.

The experiments spoken of by M. Ducretet are now being carried on at his Paris laboratory. On the top of the building passersby may see a mast 20 meters (65 feet) high. A wire passes along the top and is connected below with an electric conductor, a Ruhmkorff coil, and an accumulating battery made after a special plan. The machine is set in motion by pressing on a handle. By manipulating this, a telegram can be sent as well as by an operator seated before his machine. It would seem that the message would stop when it reaches the end of the wire. This is not the case, for it is transmitted to a receiving machine 4 kilometers (2.48 miles) distant. To secure this transmission there must be no such obstacle as an iron wall or shaft between the two points. A simple wall does not interrfere for a space of several hundred meters.

As soon as the transmitter is put in motion, the receiving machine—the ordinary Morse machine—begins to work automatically; the dispatch arrives as well as if a wire connected the two points. A bell rings to indicate the transmission of a message, but the paper rolls out automatically to receive the words printed by the Morse alphabet, and when the message is completed the paper ceases to roll.

The message is received through a garret window, from which hangs a wire. This wire communicates with the Morse machine through a box containing special machinery. As soon as the telegram starts this begins to tick, and an experience telegrapher might spell out the telegram before it appears on the paper..

For the use of specialists and for laboratory experiments a small transmitter has been constructed which has no mast and has no wire running above. In the course of experiments, this little box has even been disconnected from the wire hanging from the window, and the transmitter started. The same ticking began, and the vibrations were plainly felt by taking it in the hand.

The box can be opened without danger and everything withdrawn. There will be found in it dry piles, small wire coils, and various apparatus known to electricians. Profane eyes see a little hammer that strikes on a tube when the current that transmits the telegram passes. The stroke of the hammer against the tube produces the ticking sound; and it is this tube, the essential part of the construction, that is the invention of M. Branly, a native of France. It is claimed in France that to this tube is due wireless telegraphy, both in this and other countries.

W. P. ATWELL,
Roubaix, Nov. 23, 1898. Commercial Agent.

INSULATION.

INSULATING MATERIAL FROM FISH OFFAL.

According to a paragraph by E. Andreoli, in the "Electrician," the preparation of insulating materials from fish offal has already become an industry of importance in England, while nothing is done in France. A great many things are made of fiber or fish—pulleys, wheels, panels, objects of art, etc.—and impregnated with the oil extracted from fish at a very moderate expense; such objects are said to be superior to vulcanized fiber. The oil is ozonized, when it at once thickens considerably. Continued treatment with ozone improves the oil much in color, smell and in other respects. This treatment is, of course, not inexpensive. But Andreoli himself has greatly increased the efficiency of ozonizers and has constructed apparatus which justify us in regarding ozone as an oxidizing agent in the technical sense.

ANGOLA RUBBER.

The Belgian Vice-Consul at Mossamedes reports that rubber exported from Benguela is in the form of elongated chestnuts, the natives giving to each piece the name of "metari," of which about forty go to a kilogramme. Almadina, which is sometimes exported in small quantities from the port of Mossamedes, is a substitute for caoutchouc, reaching the market in the shape of round balls, weighing about 100 grammes each. At present rubber is the principal export product of Angola, and as it is submitted to an export duty of 3 per cent. when it is directed to a Portuguese port, and of 15 per cent. when to a foreign port, its export constitutes one of the most important resources of the Colonial Budget of Angola.

BUSINESS NEWS.

SPECIAL EXPORT COLUMN.

TOTAL AMOUNT OF ELECTRICAL EXPORTS FOR WEEK ENDING DEC. 31, 1898, $47,815.00.

New York, N. Y., Dec. 31, 1898.—The following exports of electrical material are from the port of New York for the week ending this date:

British East Indies.—Nine cases electrical material, $210.

Berlin.—Two cases electrical machinery, $200.

Brazil.—Thirty-three cases electrical machinery, $1,748.

British Australia.—Forty-four cases electrical machinery, $3,700.

Bremen.—One case electrical machinery, $315.

British Guiana.—Eight packages electrical material, $83.

British Possessions in Africa.—One case electrical material, $60.

British West Indies.—Twenty-one packages electrical material, $663.

Central America.—One hundred and eighty-nine packages electrical material, $4,838.

Cuba.—Thirty-five cases electrical material, $2,441.

Ecuador.—Forty-five packages electrical material, $652.

French West Indies.—One package electrical material, $18.

Genoa.—One case electrical material, $130; two cases electrical material, $33.

Hamburg.—Twenty-two cases electrical material, $1,183; 1,224 gallons varnish, $3,100; 99 cases electrical material, $17,176.

Hayti.—Five packages electrical material, $187.

Havre.—Five packages electrical vehicles, $1,875.

Liverpool.—Fifty-seven packages electrical material, $2,063.

London.—One case electrical instruments, $550; 110 cases electrical machinery, $3,800; 16 cases electrical material, $612.

Manchester.—One case electrical machinery, $300.

Marseilles.—Two cases electrical machinery, $100.

Milan.—One case electrical material, $20.

Peru.—Eighteen packages electrical material, $341.

Santo Domingo.—Four packages electrical material, $45.

Siam.—Eleven packages electrical material, $574.

Venezuela.—Two hundred and seventy-eight packages electrical machinery, $698.

TELEPHONE CALLS.

Colville, Wash.—Columbia and Northern Telephone and Telegraph Co. has been incorporated, with a capital stock of $15,000.

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Columbus, O.—Columbus Citizens' Telephone Co. has been incorporated by H. D. Critchfield, E. R. Sharp, J. B. Hanna, J. B. Hoge and others, to operate local telephone system. Capital stock, $500,000.

Columbia, Mo.—The Columbia Telephone Co. has been incorporated by E. W. Stephens, J. A. Hudson, A. W. McAlester and others. Capital stock, $5,000.

Mexico, Mo.—The Lafayette Telephone Co. has been incorporated by D. B. Moore, E. D. Graham and others to construct and operate telephone systems. Capital stock, $12,500.

Florence, S. C.—The Florence & Allison Telephone Co. has been incorporated, with R. C. Commander president, and C. Poston secretary and treasurer. Capital stock, $1,000.

Lexington, Tenn.—The Lexington Telephone Co. has been incorporated by John E. McCall, H. E. Graper, E. J. Timberlake and others. Capital stock, $2,000.

Greencastle, Ind.—Putnam County Telephone Co. has been incorporated by J. Richardson, F. G. Gilman and C. C. Hurst. Capital stock, $10,000.

Dillon, S. C.—The People's Telephone Co. has been incorporated by C. A. Woods, E. L. Moore and John Willcox.

Waco, Tex.—The Electrical Construction Co. has been incorporated by E. Botan, W. W. Seley, S. Sawyer, E. N. Stephenson, J. B. Earle and others, to construct, maintain and operate telephone lines. Capital stock, $35,000.

POSSIBLE INSTALLATIONS.

Eau Claire, Wis.—The Chippewa Valley Electric Railway Co. has decided to put in a large power plant to operate its lines, and will also bid for the contract for city lighting.

Owenton, Ky.—Arnold & Riley contemplates the establishment of an electric light plant.

Lake Providence, La.—The Mayor may be addressed concerning the proposed issuance of $7,500 in bonds to buy an electric lighting and water supply system and for other purposes.

Baltimore, Md.—The Tuxedo & Embla Park Water & Light Co. is arranging to award contracts soon for the construction of its proposed electric light and water plants.

NEW INCORPORATIONS.

Dover, Me.—Milo Electric Light and Power Co. has been organized, with Julian d'Este president and treasurer, for the purpose of heating and lighting the towns of Milo, Sebec and Brownville. Capital stock, $10,000.

Ottawa, Can.—The Metropolitan Electric Co. has been incorporated with a capital stock of $500,000.

Elizabeth City, N. C.—The Carolina New Light Co. has been organized by J. B. Griggs, W. T. Old, D. B. Bradford and others. Capital stock, $25,000.

Columbus, O.—American District Telegraph Co. has been incorporated by H. D. Bennett, J. F. Miller, W. F. Bardell, G. W. Patterson and A. M. Schayer. Capital stock, $50,000.

BUSINESS CHANGES.

Somerville, Mass.—Lemuel Mellett, electrician, has filed a petition in bankruptcy. Liabilities, $6,215; assets, $500.

STREET RAILWAY NEWS.

Hartford, Conn.—An electric line will probably be constructed between Enfield and Somers.

NEW YORK ITEMS.

THE WESTON ELECTRICAL INSTRUMENT CO., Newark, N. J., is well pleased with the 1899 outlook. They have now in course of construction a large addition to their already extensive works, in order to successfully meet the demand for their instruments.

H. C. BECK, president of the W. C. Vosburgh Manufacturing Co., Ltd., 269-281 State street, Brooklyn, the largest gas and electric fixture house in the country, finds the outlook for 1899 excellent, and his company is rushed in order to keep up with the orders being received.

F. C. ROSS, 255 Greenwich street, manufacturing electrician, finds business in a very prosperous condition, with bright prospects for next year.

THE GARVIN MACHINE CO., Spring and Varick streets, are the largest manufacturers of metal working machinery in the Eastern States, and carry in stock for immediate delivery all styles to meet the demands of the most careful and painstaking buyers. Their business has grown to such large proportions since their fire last year that they are making extensive preparations for a larger and increased business during the next year.

SCHIFF, JORDAN & CO., 232-234 Greenwich street, without doubt manufacture one of the best enclosed arc light carbons. The demand for their famous arc light carbons has trebled their business for one year, and they expect to quadruple the same during the next year. They found it advantageous and at the same time necessary to add a general supply line to their business some time ago, and are so well pleased with the success of the same that they are making preparations to increase the line during the coming year.

HATZEL & BUEHLER, 114 Fifth avenue, electrical engineers and contractors, are the pioneers in this particular field and are practically the only electrical engineering and contracting firm not offering any specialties or novelties. They are thus enabled to devote all their time and attention to the supervision of installations without being hampered by any outside ties to the detriment of the interest of their clients. Their prospects for 1899 are very bright.

MR. GEORGE L. WILEY, the Eastern manager of the Standard Underground Cable Co., Telephone Building, has lost none of the suavity of his manners and still possesses the same magnetic qualities which have heretofore attracted buyers. Judging by the way orders are flowing into his office, this quality seems to be on the increase, and we hope the New Year will bring Mr. Wiley all the prosperity wished for.

THE PARTRIDGE self lubricating carbon brush for motors has been greatly improved, and as a proof of this the Partridge Carbon Co. state that they cannot keep up with the demand for the same, and are preparing to increase the output for 1899.

DR. J. W. DE LERY, one of the popular men among the electrical trade, is receiving the congratulations of his many friends upon the great success with which his new company is meeting in the introduction of the new De Lery incandescent gas light. A call at the offices of the company, at 258 West Twenty-third street, will convince our readers of this.

A. H. PATTERSON, manager of the Phoenix Glass Co., 15 Murray street, is well satisfied with the past year's business, and is preparing to double the same during 1899.

"OKONITE," the most famous brand of rubber insulated wires and cables, and which was awarded a medal at the 1889 Paris exposition and the World's Fair, at Chicago, in 1893, for the best rubber insulation, is looking forward to the 1900 Paris exposition with great confidence in its ability to again carry off the palm. We wish it a "Happy New Year" and success in 1900.

A. L. BOGART CO., 123 Liberty street, has doubled its business during the last six months and expects to double its present business during 1899.

J. JONES & SON, 64 Cortlandt street, report a good paying business during 1898, and are looking forward to 1899 as another big interest paying year.

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THE EDISON, JR., LAMP, under the management of Mr. C. F. Stilwell, has had a very prosperous year, and will no doubt shine brightly during the coming year.

THE STANDARD UNDERGROUND CABLE CO., Westinghouse Building, Pittsburg, Pa., are sending out to their friends and customers a combination foot rule and wire gauge, as a reminder that they are "on earth," and that they would appreciate their orders for their various kinds of wire. As a reminder, the above article is unique and we would advise our readers to write for one.

THE ABENDROTH & ROOT MANUFACTURING CO., 28 Cliff street, New York City, manufacturers of the famous Root boilers, state that they have nearly doubled their business during 1897 and 1898, and are looking forward to an equally large increase during 1899.

STEIN & LANGL 220-222 Centre street, experimental and model work, express themselves as well satisfied with the past year's business and state that the outlook for the coming year is very favorable.

CHARLES J. BOGUE, 215 Centre street, is greatly pleased with the success which his "American" enclosed arc lamp has met with, and will keep the same well to the fore during '99.

"TUPPER" grate bars are being received with favor wherever introduced, and are living up to the high standard set for them by the W. W. Tupper & Co., 39-41 Cortlandt street.

THE EDISON DECORATIVE AND MINIATURE LAMP DEPARTMENT, of Harrison, N. J., has found the closing year a banner year for their well-known lamps, and predict a steadily increasing business for 1899.

THE NORTHERN ENGINEERING CO., Cortlandt street, is closing the year in a most satisfactory manner to themselves. They have received the Government contract for fitting out a complete steam plant for the eelctric light plant at the Brooklyn Navy Yard. A large sum of money will be invested in this plant, and Messrs. Kloman & Hoffman are able to fill this order satisfactorily. The new year, therefore, looks very auspicious to them.

SCHMIDT & BRUECKNER, 207 Greenwich street, makers of fine telephones, are greatly pleased with their business, as the same has doubled itself during 1898, and they are therefore contemplating their removal to larger quarters during the coming year, in order to be able to meet the ever-increasing demand for their well-known goods.

WESTON STANDARD

PORTABLE DIRECT READING

VOLTMETERS AND WATTMETERS

For Alternating and Direct Current Circuits.

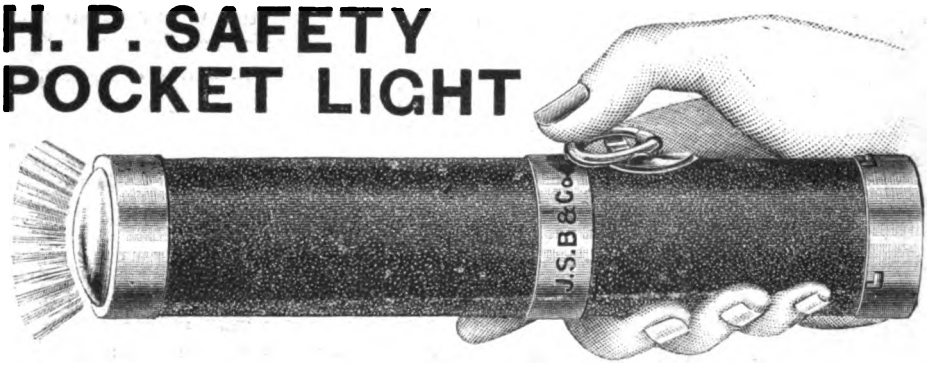
The only standard portable instrument of the type deserving this name.

Write for Circulars and Price List 8 and 9.

WESTON ELECTRICAL INSTRUMENT CO.

114-120 WILLIAM STREET, NEWARK, N. J.

H. P. SAFETY POCKET LIGHT



AN EVER-READY ELECTRIC LIGHT

For Electricians, Engineers, Navigator Machinists, Miners, Hunters, Physicians, Watchmen and Policemen, and for all purposes where a safe and handy flash light is desired. LIGHTS AND GOES OUT AT WILL. Cannot be blown out.

Gives from 6,000 to 8,000 lights before new battery is required. No wires to get out of order. No chemicals to spill; self contained. Can be carried into a cellar full of leaking gas, into an oil tank, alcohol and malt vats, or placed in a keg of powder without the slightest danger of explosion.

No.	Size.	Net Wgt.	Vts.	Complete by mail.
1	1¾x9 in. (pocket)	1 lb.	3½	$3.00
3	1¾x14 in. (large)	1½ lb.	5	5.50

James S. Barron & Co., Manufacturers of and Wholesale Dealers in General Electrical Supplies, 24-30 Hudson St., NEW YORK.

75c. "VULCAN STYLOGRAPHIC PEN. 75c.

"INDEPENDENT" FOUNTAIN PEN.

PRICE, WITH ENGRAVED HOLDER, $2.00. SAME WITH GOLD BANDS, $2.50.

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